The Ohio Naturalist

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The Ohio Naturalist,

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THE TWIG GIRDLER.*

W. A. MATHENY.

Oncideres cingulatus (Say). **Order Coleoptera; family Cerambycidæ.**

"A thick-bodied longicorn, dark gray beetle about .5 inch long, with its wing-covers sprinkled over with faint tawny yellow dots."

In making a study of the galls of this community during the fall of 1907, I came across the work of the "Twig Girdlers." These singular beetles appear in Ohio from the middle of August until the middle of September. Figure 1 represents the beetle and the incision it makes. According to Slingerland, this beetle always works head downward. This would discredit the drawing by Riley. Prof. Glenn W. Herrick says, in his paper on "The Pecan Pruner" (O. texana Horn.) that the beetle works head downward.

Professor Haldeman states that "both sexes are rather rare, particularly the male, which is rather smaller than the female, but with longer antennae." The female does all the work. She makes perforations (Fig. 1, b) in the branches in which she deposits her eggs (one of which is represented of the natural size at Fig. 1, e.) She then proceeds to gnaw a groove, of about a tenth of an inch wide and deep, around the branch and below the place where the eggs are deposited so the exterior portion dies and the larva feeds upon the dead wood.

Mr. James Brodie describes the manner of cutting of the **O. texana** as follows:

"In starting work, a patch the desired width of cut is cleaned and the bark eaten. Then the powerful mandibles are brought to work on the wood. A cut is first made at the top, then the head moves down to

* Contribution from Biological Laboratory, Ohio University.

the bottom, where a corresponding cut is made; then working from the bottom cut, the wood fiber is raised and as the piece was cut free to start with at the top, it is already detached when the piece is torn loose to the top cut. Then another cut is made at the top; then at the bottom, and so on till the insect reaches in as far as it can conveniently. It then moves to either side of this cut, eats off another strip of bark and goes to work on the wood as before."

In this study my observations are confined to the following trees: Elm, Hickory, Linden, Honey Locust and Persimmon.

Manner of Girdling: The Elm branches were girdled as shown in Figure 2. The diameter of the girdled branches varies from one-fourth to one-half inch, and the depth of the grooves varies from one-tenth to one-eighth inch. These measurements hold good for the Hickory, the Persimmon, and the Honey Locust also. In all instances observed on the elm the branches were completely girdled and all in the same manner. Attacks on this tree were not numerous.

Figure 3 shows the manner of girdling the Hickory. The grooves were cut in the same way as on the Elm tree branches. Attacks on this tree were a little more numerous than on the Elm. Eight months after they were girdled these branches (Fig. 3) had not broken off the tree. I found a few branches in their natural position on the tree twenty months after they had been girdled.

The Linden suffered more than either of the above trees. Figure 4 shows that these branches are not girdled, they are cut off. For a short time in the fall they can be seen hanging by the small thread of bark which is left (Fig. 5). They soon break off and fall to the ground, almost with the first wind. On a small tree about twenty-five feet high I counted twenty-four branches cut off as shown in Figure 5. In every instance observed the Linden branches were cut off and not girdled.

The Honey Locust was gridled in the same manner as the Elm and the Hickory, and suffered more than all the other trees combined. On one field trip the girdled branches on the first twenty Honey Locust trees were counted. The trees were taken as they were found. No sorting was done. The result of the count is given below:

Number of Tree.	Number of branches girdled.	Number of Tree.	Number of Branches girdled.
1	18	11	18
2	5	12	24
3	10	13	8
4	10	14	4
5	45	15	6
6	19	16	15
7	10	17	18
8	12	18	5
9	6	19	21
10	3	20	11

The Persimmon tree branches were girdled in the same manner as the Honey Locust. A grove of Persimmon trees near New Plymouth, Vinton County, was found in which all of the trees had been attacked. Figure 9 shows the method of the workman. This branch was one of the largest girdled branches found. A great many of the branches were in their natural position on the tree, and from the strength required to break them off I judge that under ordinary circumstances they would remain there a year longer.

On this trip to Vinton County it was observed that the Hickory and the Honey Locust and the Linden were girdled and cut to about the same extent as they were in this community. This would indicate that the beetle is widely distributed in this part of the State.

Eggs: The eggs were imbedded between the bark and wood. The female makes the perforations generally under each successive side-shoot, but this is by no means the rule, for eggs are found imbedded in all parts of the branch. After the egg is deposited, the female closes the hole with a gummy secretion. The eggs are about two millimeters in length, (Fig. 1, e), of a whitish color, and long oval in shape. Those under observation were probably laid in October and hatched about December.

I have examined more than a thousand girdled branches, and in every case a peculiar scarring of the bark both above and below the notch extending about one inch in each direction was observed (Fig. 11 and Fig. 12). These scars were made by the female. After laying her eggs she digs with her powerful mandibles, transverse shallow grooves one-sixteenth to one-tenth of an inch long in the bark. There can be no doubt as to her purpose in doing this. It is a precaution taken to make doubly sure that the girdled branch will die, and do away with any possibility of the bark growing together and healing the wound. Just as far as these grooves extend up and down the stem, the bark dies. It is interesting to note that in addition to girdling the branch two inches of the bark is deadened. *On some specimens these transverse grooves were observed both above and below the egg.* This was especially true of the Hickory. The grooves extended along the probable course which the burrowing larva would take. This was not true for all eggs laid in the same branch. Several instances were noted where these grooves were made above and below the eggs which were laid away from buds and branches. It is done to deaden the bark and prevent growth from crushing the egg. Prof. Herrick mentions this in regard to O. texana, but he does not mention the grooves made both above and below the incision. We conclude that the species differ in this particular.

Larvae: The larvae are white in color and from one-half to three-fourths of an inch long. They vary very much in size. One would judge that those destined to produce females are larger than the others. The larvae found in the deadened Elm branches were smaller than those found in the girdled Honey Locust branches. Probably the difference in the kind of nutriment obtained determines the size of the larvae.

When examined with a lens, the body is found to be sparsely covered with short, dark hairs. These hairs are more numerous on the anterior end than on the posterior end. The mouth parts are brown. After hatching they burrow in the wood and remain there until late in the following summer. Beginning early in the spring they excavate galleries in the dead branch just beneath the bark. Frequently they are found burrowing in the solid wood, and still more frequently in the pith. Their growth is very slow and it takes very little wood to satisfy them.

In one instance a larva came to maturity and changed to a pupa in a gallery two inches long. This gallery was about one-eighth of an inch in diameter. Two pupae were found side by side in separate galleries in a branch one-half inch in diameter. At present I am unable to state definitely how long the larvae exist in these cut-off branches. Some at least spend two winters in the wood, but this can not be said of all. This point is now under observation.

Before the larva changes to a pupa, it cuts a pinhole in the bark near the end of the gallery, and closes the opening of the burrow with fine shavings. This gives the pupal cell an opening to the outside for air and egress when the proper time comes.

In a girdled Hickory branch now before me the larvae average one-fifth inch in length. They are at work in galleries one-fourth inch in length, and none of them have burrowed deep into the wood. These larvae were hatched more than five months ago. This shows plainly how slow their growth is. Owing to the scarcity of full grown larvae we can logically conclude that these small larvae will be our girdlers this coming Fall. Some of the smaller and poorly nourished larvae will certainly pass another winter in the branches. In every instance observed the two-winter larvae were found only in the Honey Locust branches. The extreme hardness of this wood might account for this delayed development.

The number of eggs laid in girdled branches varies from three to twenty. Below is given a record of the number of eggs laid in twenty branches. The count was made at random, and includes branches from different trees.

No. of Branch.	No. of Eggs.	No. of Branch.	No. of Eggs.
1	12	11	11
2	5	12	13
3	8	13	7
4	6	14	4
5	11	15	8
6	9	16	3
7	18	17	16
8	14	18	12
9	5	19	6
10	20	20	17

Pupae: The eggs laid in October, 1907, have not gone into the pupa state yet, May 30, 1908. Those laid in October, 1906, passed into the pupa state sometime between March and May of this year. The pupae are white. They vary in length from five-sixteenths to five-eighths of an inch. They lie in the galleries which were described above.

Adults: About the first of June adults were found nicely hidden away in the galleries. On being removed to the open, they flew away with perfect ease. Further observations are now being made with the hopes that more light may be thrown on the daily activities of the adult form.

In this work I received many valuable suggestions from Dr. W. F. Copeland and Dr. W. F. Mercer, to both of whom I feel deeply indebted.

LITERATURE.

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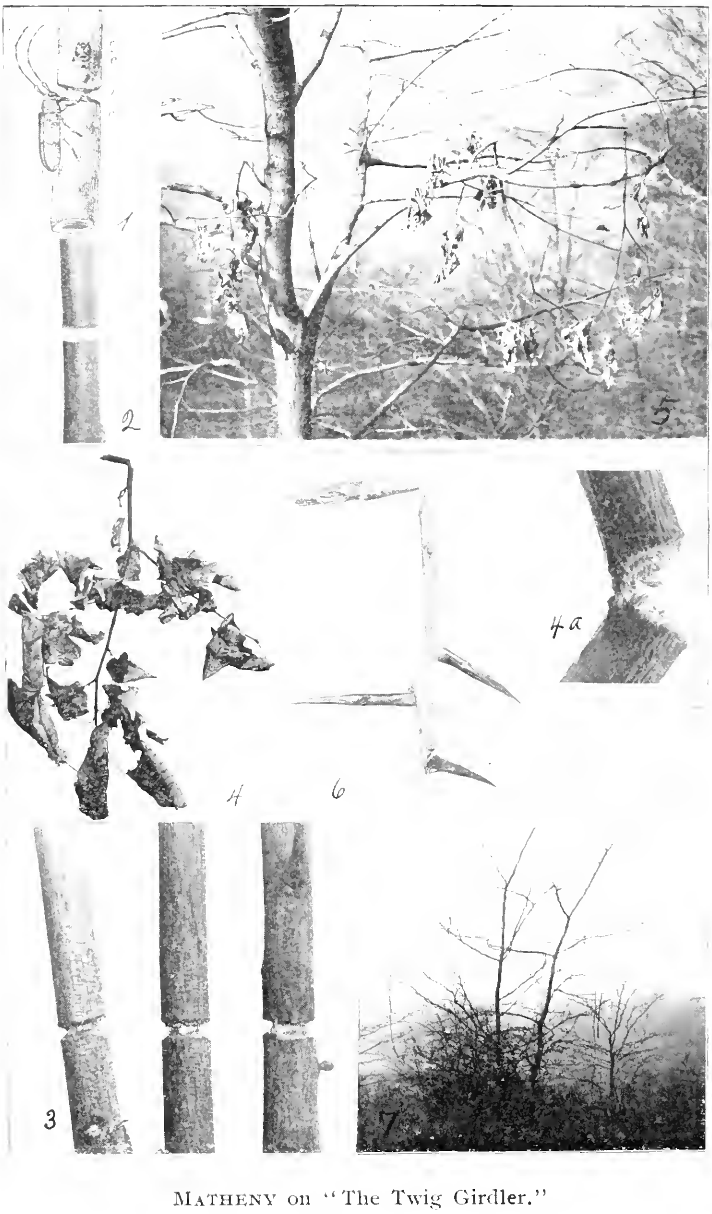
2. E. E. FAVILLE and P. J. PARROTT. Elm Twig-Girdler, Kansas State Agricultural College Bull. 77.

3. A. S. PACKARD, JR. Insects Injurious to Forest and Shade Trees. U. S. Entomological Com. Bull. 7.

EXPLANATION OF FIGURES OF PLATES I AND II.

FIG. 1. Oncideres cingulatus. After Riley.
FIG. 2. Elm twig.
FIG. 3. Hickory twigs.
FIG. 4. Showing the manner of cutting off the Linden branches.
FIG. 4a. Large view showing details of cut.
FIG. 5. Three Linden branches hanging ready to drop at the first wind.
FIG. 6. Honey-locust twig.
FIG. 7. A Honey-locust shrub on North Hill, Athens, O. Forty-five branches girdled.
FIG. 8. A Honey-locust shrub on North Hill, Athens, O. Thirteen branches girdled.
FIG. 9. Girdled twig of Persimmon.
FIG. 10. Girdled Persimmon branches. Photographed near New Plymouth, Vinton County, O.
FIG. 11. Girdled Persimmon branch showing transverse scars.
FIG. 12. Girdled Elm branch showing transverse scars.

OHIO NATURALIST. *Plate I.*



MATHENY on "The Twig Girdler."

MATHENY on "The Twig Girdler."

AN INTERESTING BOTRYCHIUM HABITAT.

JOHN H. SCHAFFNER.

A common experience for a botanist is to go collecting in a well-worked locality and find some interesting plant that was not known there before. Such an experience came to me the past summer on Cedar Point, Erie County, Ohio. The Point has been worked botanically for many years by various collectors, including myself.

One day in the last week of June, I visited the north bank of the large lagoon in the woods north of the summer resort. I gathered a number of plants of no special importance and took them to the Laboratory in my vacsulum for study. The following morning while throwing out the material, I noticed a broken specimen of Botrychium simplex Hitch. clinging to one of the plants. I was naturally delighted, for no specimens of this plant were known from Ohio although the name was on the State list. I returned to the place and soon found the plants in abundance. A little farther on I found Botrychium neglectum Wood, also in abundance. This was another rare Ohio plant, being known only from a few localities in the north-eastern part of the state. Then I concluded that there certainly must be others. So a little search brought to light Botrychium obliquum Spreng. besides Botrychium virginianum, which was on the Cedar Point list, being quite common. No more Botrychiums were found although I thought there should be others, but the search, made partly on hands and knees, ended with adding Ophioglossum vulgatum L. to the collection. This made six of the Ophioglossaceae growing in an area not over two rods in diameter.

Not only were the sporophytes found but gametophytes of all the species were dug up. These were mostly located by the tiny juvenile sporophytes projecting above the surface of the soil. Botrychium dissectum has the first tiny leaf of the typical shape. A whole series of juvenile stages was seen without the slightest indication of a generalized type of leaf. I naturally supposed that the first leaf would have some of the characters of Botrychium obliquum of which species it is by some thought to be a variety or form. The plants could, however, not be more clearly defined. They show the specific character from the beginning. This seemed especially interesting since so commonly there is a very decided similarity of juvenile forms in closely related species.

The place is an open thicket of Rhus hirta and other small trees and shrubs. The soil is sandy and rich in humus, partly dry and partly swampy. It is hoped that notwithstanding its nearness to the summer resort, this habitat will be undisturbed for

some time to come. The two rare species, Botrychium simplex and Botrychium neglectum, were past their prime. They probably begin to ripen their spores about the 15th of June. Time prevented making a thorough study of the surroundings and there may be other surprises in the future for the careful observer.

THE GYMNOSPERMS OF OHIO.

John H. Schaffner.

Ohio lies south of the great northern conifer belt of North America and since there are no mountains in the state, the Gymnosperms do not constitute an important part of the flora. There are but 11 species, one of which is probably accidental and has been reported from but one county. The only species of general distribution is the Red Juniper, but species of Pinus, Picea, Abies, and other genera are quite commonly cultivated in all parts of the state.

Subkingdom, GYMNOSPERMAE. Gymnosperms. 500 living species.

Plants in which the sporophytes are woody perennials with open carpels (megasporophylls) without a stigma, and hence with naked ovules and seeds, the pollen (male gametophyte) falling directly on the micropyle of the ovule (megasporangium); flowers monosporangiate, usually developing as cones but sometimes very simple; female gametophyte with numerous cells but without polar cells and thus without true endosperm as in the Angiosperms; male cells usually two, either nonmotile sperms or developed as spirally coiled multiciliate spermatozoids.

KEY TO THE NATIVE AND CULTIVATED GENERA.

1. Foliage leaves needle-shaped, narrowly linear, subulate, or scale-like; conifers, or in one case a dicotyl with delicate twigs and minute leaves. 2
1. Foliage leaves fan-shaped with dichotomous venation, a number on thick, wart-like, persistent dwarf branches. . . . . **Ginkgo.**
2. Without dwarf branches. 4
2. With typical dwarf branches, persistent for more than 1 year. 3
2. With feather-like dwarf branches, deciduous each year, the linear leaves spreading into 2 ranks. **Taxodium.**
2. With delicate spray-like twigs deciduous each year; leaves scale-like, minute; a dicotyl. . . . . **Tamarix.**
3. Dwarf branches small, self-pruned, with 2-5 foliage leaves. . . . **Pinus.**
3. Dwarf branches thick, wart-like, persistent, with numerous deciduous leaves . . . . **Larix.**
4. Leaf buds scaly; leaves scattered. 5
4. Leaf buds not scaly, naked; leaves opposite or whorled. 7
5. Leaf scar on a sterigma, the twigs covered with scales representing the leaf bases. 6
5. Leaf scar on the bark; twigs without scales; leaves flat. . . . . **Abies.**
6. Leaves flat, those on the upper side of the twig much shorter than the lateral ones; trees. . . . . **Tsuga.**

6. Leaves flat all of about the same length; ours a shrub.........**Taxus.**
6. Leaves more or less 4-sided, spreading in all directions..........**Picea.**
7. Twigs decidedly flattened and fan-like, the leaves small, scale-like, and appressed, of two types, the dorsal and ventral broader and more abrupt at the apex; scales of the carpellate cone not peltate. **Thuja.**
7. Twigs little or not at all flattened, the leaves either scale-like, appressed, and nearly or quite similar, or subulate and spreading; fruit berry-like when ripe or the scales of the carpellate cone peltate.. 8
8. Leaves all subulate and spreading; or partly scale-like, 4-ranked and appressed; carpellate cone developing into a bluish-black berry-like fruit. (Retinispora forms of Thuja might be sought for here also) .... **Juniperus.**
8. Leaves all small, scale-like, appressed, nearly or quite similar; fruit a dry cone.. 9
9. Scales of the carpellate cone several-seeded................ **Cupressus**
9. Scales of the carpellate cone 2-seeded ....**Chamaecyparis.**

Class, CONIFERAE. Conifers. 350 species.

Sporophytes developing as shrubs or large trees, much branched, with or without dwarf branches; stems with a normal cambium, no vessels in the secondary wood, resin nearly always present; leaves mostly small, entire, linear, lanceolate, subulate, or scale-like; flowers monosporangiate, monoecious or dioecious; seeds and female gametophyte rather small, ovules without pollen-chamber, cotyledons 2-15, always free; sperm cells 2, not motile, no cilia being present.

Order, PINALES.

Conifers with both the stamens (microsporophylls) and carpels (megasporophylls) in cones, usually numerous.

Pinaceae, Pine Family.

Leaf-buds scaly; carpels of the cone numerous, with two inverted ovules on the ovuliferous scale; stamens with two microsporangia.

Pinus L. Pine.

Resinous evergreen trees with small dwarf branches bearing 2–5, narrow foliage leaves; dwarf branches and ordinary twigs covered with scale leaves. Dwarf branches self-pruned after a number of years. Carpellate cones woody, with numerous carpels. Important lumber and turpentine trees.

1. Dwarf branches with 5 foliage leaves; ovuliferous scales little thickened at the tip.................................. **P. strobus.**
1. Dwarf branches with 2-3 foliage leaves; ovuliferous scales much thickened at the tip.. 2
2. Dwarf branches with 3 foliage leaves, rarely 2 or 4, the leaves 3-5 in. long; carpellate cones ovoid.......................**P. rigida**
2. Dwarf branches normally with 2 foliage leaves 3
3. Twigs glaucous; leaves slender, $2\frac{1}{2}$–5 in. long; buds not very resinous; prickles of the ovuliferous scales short and small....**P. echinata.**
3. Twigs glaucous; leaves stout, $1\frac{1}{2}$–$2\frac{1}{2}$ in. long; buds very resinous; prickles of the ovuliferous scales long and stout....**P. virginiana.**

1. **Pinus strobus** L. White Pine. A large tree with nearly smooth bark, except when old; branches horizontal, in whorls. Often forming dense forests. Wood soft and straight-grained. One of the most valuable timber trees in the world. Northeastern part of Ohio to Erie County.

2. **Pinus virginiana** Mill. Scrub Pine. A slender, usually small tree with spreading or drooping branches; the old bark flaky and dark-colored. Wood very resinous, soft and durable, but of poor quality. In sandy soil. From Fairfield County southward.

3. **Pinus echinata** Mill. Yellow Pine. A large tree with spreading branches; leaves sometimes in 3's. Wood rather hard and very valuable; much used as lumber. Produces shoots from stumps. In sandy soil. Probably accidental in Ohio; Auglaize County.

4. **Pinus rigida** Mill. Pitch Pine. A tree with spreading branches, the old bark rough and furrowed, flaky in strips. Sprouts readily from the stump if cut down or burned. Wood rather hard and brittle and full of resin; used for fuel, charcoal and coarse lumber. A source of turpentine to a limited extent. In dry sandy or rocky soil. Scioto, Jackson and Fairfield Counties.

Larix Adans. Larch.

Tall pyramidal trees with horizontal or ascending branches and with clusters of narrowly linear, deciduous leaves on thick wart-like dwarf branches. Carpellate cones woody, with numerous carpels,

1. **Larix laricina** (DuR.) Koch. Tamarack. A slender tree with close or at length scaly bark. Wood hard, durable and very strong. Carpellate cones reddish purple when young. In bogs, swamps, and about the margins of lakes. Northern third of the state.

Tsuga Carr. Hemlock.

Evergreen trees with slender horizontal or drooping branches. Leaves flat, narrowly linear, spreading more or less into 2 ranks. Leaf scars on short sterigmata. Carpellate cones pendulous.

1. **Tsuga canadensis** (L.) Carr. Hemlock. A tall tree with slender, horizontal or drooping branches, the old bark flaky in scales. Wood very coarse. Self-prunes twigs. Eastern half of Ohio, and occasional toward the west.

Juniperaceae. Juniper Family.

Leaf-buds naked; carpels of the cone few, opposite; stamens with 3–8 microsporangia.

Thuja L. Arborvitae.

Evergreen trees or shrubs with flattened fan-like twigs. Carpellate cones ovoid or oblong with dry coriaceous scales, not peltate.

1. **Thuja occidentalis** L. Arborvitae. Usually a small, conical tree with fan-like branches. Self-prunes twigs. Wood light and durable. Usually in wet soil and along the banks of streams. Champaign, Franklin, Greene, Highland and Adams Counties.

Juniperus L. Juniper.

Evergreen trees or shrubs with small globose, berry-like bluish or blackish cones.

1. Leaves all subulate, prickly pointed, verticillate; cones axillary 2
1. Leaves of 2 kinds, scale-like and subulate, opposite or verticillate; cones terminal .... **J. virginiana.**
2. Erect trees or shrubs; leaves slender, mostly straight ..... **J. communis.**
2. Low depressed shrubs; leaves stouter, mostly curved .... **J. nana.**

1. **Juniperus communis** L. Common Juniper. A low tree with spreading or drooping branches and shreddy bark. Goats are poisoned from eating the leaves. On dry hills. In the northern part of Ohio, as far south as Fairfield County.

2. **Juniperus nana** Willd. Low Juniper. A depressed rigid shrub usually with creeping radiating branches, the ends erect or ascending, thus forming circular patches. In dry open places. Cedar Point, Erie County.

3. **Juniperus virginiana** L. Red Juniper. A tree with spreading, ofter irregular branches, when old, but conic in shape when young. Self-prunes twigs. Wood very valuable, light, straight-grained, durable and fragrant; used almost exclusively in the manufacture of lead pencils. Often infested with the "cedar-apple" fungus. Poisonous to goats. Common on hills and bluffs; general in Ohio.

Order, TAXALES.

Conifers with the stamens (microsporophylls) in cones, but the carpels (megasporophyils) mostly single; ours with a red fleshy disk surrounding the ripe seed.

Taxaceae, Yew Family.

Staminate (microsporangiate) cone with 3–5 stamens; carpels solitary with one or two erect ovules.

Taxus L. Yew.

Evergreen trees or shrubs without resin, with spirally arranged, short petioled, linear, flat leaves spreading into 2 ranks. Fruit with a bony seed surrounded by a fleshy red disk.

1. **Taxus canadensis** Marsh. American Yew. A low, usually straggling shrub with linear leaves green on both sides. The leaves are supposed to be poisonous to stock. On rocky banks and in woods. Northern Ohio, as far south as Fairfield and Greene Counties.

THE LABRADOR TEA IN OHIO.

OTTO E. JENNINGS.

In the OHIO NATURALIST for December, 1908, Professor J. H. Schaffner presents a list of "Plants on the Ohio State List not Represented in the State Herbarium" and proposes to strike off these names if no proper evidence of the occurrence of the plants in question in Ohio is forthcoming.

Yesterday there came to my hands from my friend, Mr. Roscoe J. Webb, of Garrettsville, Portage County, Ohio, specimens of three plants which he and Mr. A. D. Robinson, of Ravenna had collected in a tamarac bog near Shalersville, Portage County, May 24 of this year. The plants were Wolffia columbiana Karst., Ilicioides mucronata (L.) Britt., and Ledum groenlandicum Oeder.

Mr. Webb says the Ledum is abundant at this place and that he has known of this locality for about ten years. The specimens sent me were in good flower and were evidently taken from plants in vigorous condition. This record is noteworthy in that Mr. Webb's station evidently constitutes the only authentic occurrence of the plant in Ohio. However, the writer has discovered a patch of Ledum, about one-half acre altogether, in the great Pymatuning Swamp, near Linesville, Pennsylvania, and only about six miles from the Pennsylvania-Ohio state line, and it would not be surprising if other stations should be found for this species in other bogs in northeastern Ohio and northwestern Pennsylvania.

Carnegie Museum, Pittsburgh, Pa., May 27, 1909.

POTATO AGAR.

MEL. T. COOK.

The making of potato agar probably presents greater annoyances than the making of any other medium used in bacteriological and mycological laboratories. The difficulty is due to the starch of the potato becoming gelatinous and difficult to filter. For sometime the writer has been using a method which has proved very satisfactory. This method is a modification of the method in general use and it is probable that other workers may be making agar in practically the same manner. However, it has been considered advisable to publish it at this time for the benefit of any who may be experiencing difficulties in the making of this very valuable medium. The method is as follows:

A.—Melt the desired amount of agar (10, 12, or 15 grams) in 500 cc. of distilled water.

B.—Peel and slice very thin, 500 grams of potatoes and add 500 cc. of distilled water. Heat at about 60 degrees C. for one hour. Strain through cloth.

Mix A. and B. Add the white of two eggs which have been mixed in 100 cc. of distilled water. Put in autoclave and heat until clear, usually about two hours. If the total volume is now less than 1000 cc. enough hot distilled water should be added to equal that amount. Filter through cotton, titrate if desired, tube and sterilize.

Agri. Exp. Station, Newark, Del.

NEWS AND NOTES.

The annual meeting of the Ohio Academy of Science will be held at Delaware, Ohio, on the 26th and 27th of November.

The Mocking Bird in Gallia County.

Four years ago, the first Mocking Bird, Mimus polyglottus, was seen at Rio Grande. Its nest was not found. This year at least five nests were found within the village and the birds seem quite numerous through the country. Heavy winds overturned three nests and the young ones perished in spite of human efforts to replace and strengthen the nests.

Ruth E. Brockett.

MEETINGS OF THE BIOLOGICAL CLUB.

Orton Hall, April 12, 1909.

The Club being called to order by the President, the minutes of the two previous meetings were read and approved. Letters were read from the following men acknowledging invitations to the Darwin Centenary meeting.—Robert A. Dudington, of Oberlin College; President Dabney, of the University of Cincinnati, and Maynard M. Metcalf, of Oberlin College.

The resignation of Arthur H. McCray, as secretary of the Club was accepted.

The program for the evening was a discussion of the "Place of Biology in the High School and University Course." The first paper was presented by Miss Maud Flynn, on the "Place of Biology in the High School." An outline of the present course in the Columbus High Schools was given together with suggestions for improvement. The independent treatment of the subjects Botany, Zoology and Physiology was favored. The second paper of the evening was by Prof. Landacre on the "Place of Biology in the University." He stated that there seemed to be no place at present for a department of Biology in the State Universitites giving technical courses since the foundation for advanced work either in Physiology, Botany or Zoology could best be given by those departments independently. In the smaller colleges a course in general Biology can be given profitably. Profs. Osborn, Griggs, Hambleton, Schaffner, Durant, Boyd and Ostend and Miss Blair took part in the discussion which followed. The Club then adjourned.

Orton Hall, May 2, 1909.

The meeting was called to order by the President, Miss Freda Detmers. The minutes of the previous meeting were read and corrected.

The paper for the evening was presented by Prof. McCampbell, the subject for the evening being "Tumours in Animals." Tumours were classified as harmless and harmful. The harmful tumours or malignant tumours are difficult to eradicate and produce toxins. Tumours were further divided in regard to organs affected. The subject was further discussed largely from a study of domestic animals, especially the guinea pig. As to the cause of tumours nothing has as yet been determined definitely though there are a large number of theories to account for these growths.

In the discussion which followed Prof. Dachnowski and Prof. Schaffner, Miss Detmers and Miss Wilson took part.

Miss Detmers reported on a Fungus probably due to an Ascomycete following the work of Sapsuckers on Ironwood. Prof. Hambleton recalled seeing stumps of the Ironwood covered with the fungus.

W. C. Morse, Miss Hollister and Prof. Hambleton were appointed as a committee to nominate a staff for the OHIO NATURALIST.

ORTON HALL, June 7, 1909.

The last meeting of the year was called to order by the President, Miss Freda Detmers. W. C. O'Kane was unable to present his paper on the Coccidae. J. F. Zimmer presented an interesting paper on "Maple Tree Insects." The discussion was largely confined to the commoner forms of economic importance. Prof. J. C. Hambleton and Miss Stella S. Wilson took part in the discussion which followed. Chalmers De Pue then presented an outline of his year's work on the "Viability of Forest Tree Seeds."

The Nominating Committee reported the following nominations for the staff of "THE OHIO NATURALIST":

Editor-in-Chief .... JOHN H. SCHAFFNER
Business Manager .... JAMES S. HINE
Assistant Business Manager .... G. D. HUBBARD

ASSOCIATE EDITORS.

Emily Hollister .... Zoology
R. F. Griggs .... Botany
W. C. Morse .... Geology
W. C. Mills .... Archaeology
J. C. Hambleton .... Ornithology
G. D. Hubbard .... Geography

ADVISORY BOARD.

Herbert Osborn Charles S. Prosser John H. Schaffner

The report was accepted and the staff elected.

Miss Ruth A. Wardall and Marie F. McLellan were elected to membership.

H. T. OSBORN, *Secretary.*

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EVAPORATION IN A BOG HABITAT.*

MALCOLM G. DICKEY.

Within the past two years, investigations have been carried on at a bog island in the Licking Reservoir near Columbus, Ohio, disclosing the toxicity of bog water, and bog soils. The physiological aridity of this bog habitat has been discussed in two papers, (1 and 2). In connection with experiments, which are to be made upon the transpiration of bog plants, it was thought desirable to obtain direct evidence concerning the evaporating power of the air of this region. With this object in view, the data given below were collected during the past summer.

The problem of evaporation, though manifestly an important one, has received relatively little attention. Recent investigations at Salton Sea in Southern California, have brought to the attention of meteorologists, the vital importance of evaporation in the storage of water in reservoirs, for irrigation purposes in the arid regions of the west. Salton Sea, which is cut off from the Colorado River, must, in the course of ten or twelve years, it is estimated, be reduced by evaporation, and it is planned, therefore, to make a complete study of the phenomenon in that region. Readings are taken from floating tanks and pans upon water surfaces at different points on the sea, and likewise at auxiliary stations in different climates and under different conditions.

Considered purely from a physical standpoint, evaporation depends upon humidity, temperature, and wind velocity. The sun's rays influence it only as they increase the temperature of the air and of the evaporating surface. Secondary factors influencing evaporation are, however, so numerous, and difficult to separate, since they all may operate at the same time, that it is

*Contributions from the Botanical Laboratory of Ohio State University, L.

not an easy task to find a uniform and constant relationship for each one of the primary factors. It must be remembered, therefore, that the following statements from a summary of the subject in the "Monthly Weather Review" of 1907 and 1908, (8) hold true only when all other things are considered equal.

If the rainfall is uniformly distributed throughout the year, the evaporation will increase proportionately.

A heavy winter, and a light summer rainfall will, together show a small annual evaporation, and conversely.

Evaporation varies nearly inversely as the atmospheric pressure, or nearly directly as the altitude.

The rate of evaporation is nearly proportionate to the difference of temperature as indicated by the wet, and dry bulb thermometers.

As to temperature, it is found that the capacity of atmospheric air for moisture is approximately doubled with every increase in atmospheric temperature of 20° F.

Wind velocity has a marked influence upon evaporation being nearly in a direct ratio with it.

In the light of these observations, meteorologists have attempted to find the relationship existing between the various modifying factors and evaporation, and have succeeded in working out formulas by means of which the evaporation from watersheds and water surfaces can be approximated.

It should be stated that there are many obstacles to contend with in devising proper methods for measuring evaporation. It is almost impossible, in field work, to place the instrument under normal standard conditions, and also to eliminate the error caused by rainfall. It has been pointed out, moreover, that the evaporation from a large water surface cannot be calculated correctly from the evaporation of a small tank for the reason that air, moving over a water surface, absorbs moisture, and its capacity to hold water becomes gradually less.

This difficulty may be partially overcome by measuring the evaporation at numerous points on the water surface, plotting the results and drawing isothymes. By a summation of the evaporation over the areas between the isothymes, the evaporation of the whole area can be calculated with comparative accuracy.

New and more improved instruments have been devised, and are now being employed by the Weather Bureau (10) in connection with the work upon evaporation from lakes and reservoirs.

In physiological work, it has been considered preferable to obtain the evaporation readings directly by such instruments as are available, rather than to depend upon formulas, which are necessarily somewhat inaccurate, The German Forest Service (9) has used a small zinc receptacle with a wooden roof, which allows the free access of air, but excludes rainfall. Within recent years the porous cup atmometer, which will be described later, has come into use.

Livingston's experiments (3) with the atmometer at Tucson have shown that the evaporating power of the air, aside from its indirect effect upon soil moisture, is an important factor in plant development. Several species of plants were grown in soil which was kept as nearly as possible at its optimum moisture content, and their behavior in relation to the rate of evaporation was studied. Two species which were able to transmit water to the leaves faster than it was lost by transpiration, grew vigorously, even during a period of drought. Several other varieties were unable to provide the excess water for growth during the period of drought, but remained quiescent, and resumed their growth upon the return of the season of lower evaporation. Other plants not only failed to provide the excess water for growth during the drought, but did not respond even on the coming of the season of lower evaporation and soon died. It is concluded, from these experiments, that the evaporating power of the air controls desert vegetation to a great extent, for it inhibits the growth of plants which are not able to adjust themselves to the low evaporation rate, and thus plays an important part in the determination of centers of plant distribution.

Further work (4, 5,) has brought out the value of the atmometer in the differentiation of habitats. While the amount of rainfall, through its effect upon soil moisture, is effective upon vegetation over large areas, the evaporating power of the air may vary greatly within these areas, and within neighboring habitats. Data taken in the Missouri Botanical Garden showed that the average ratio of the evaporating power of the air in the open field, and in the shade of a coppice was approximately as 2.5 to 1. About the same ratio was apparent in an open strawberry patch, and beneath a shade tent.

Atmometer readings taken at Tucson, and at different altitudes in the Santa Catalina Mountains indicate a gradual decrease in the rate of evaporation with altitude. Considering as unity the standard Tucson atmometer at 2412 feet, the relative loss of the instruments at 6000, 7500, and 8000 feet, was .8, .5 and .4 respectively. These conclusions with reference to the decreasing rate of evaporation at higher altitudes have been corroborated by similar experiments conducted by Shaw in the Selkirks (6).

Transeau (7) continued the study of the relation of plant societies to evaporation. He placed instruments in different plant habitats about Cold Springs Harbor, Long Island, comparing all readings with that of a standard instrument in the Carnegie Garden. He reported an evaporation of 100% on an open gravel slide, and showed that the partial invasion of the slide by vegetation produced a decrease of 40% in evaporation. The rate in a forest habitat varied from 50% in the open wood to 10% in the swamp forest. In the light of these data, it is easy to see why plants, accustomed to the swamp environment, cannot succeed in an open woods with a rate of evaporation five times as

great. The importance of pioneer shade plants as reducers of transpiration is also pointed out.

The instruments used at Buckeye Lake were a slight modification of those used by the writers just mentioned. The evaporation takes place from the surface of an exposed porous clay cup, about thirteen centimeters in length, two and one-half cm. in diameter, and with a wall of four millimeters thickness. The upper end is closed, and rounded, the lower end is closed tightly by a perforated rubber stopper, through which passes a glass tube. This tube extends down to the bottle below, which serves as the reservoir of water. Since the instruments were to be left for rather long periods of time, a larger and more stable form of reservoir was required. In place of the "Mason" jar and cork stopper, a bottle of 5000 cc. capacity was used, with a neck of sufficient slope so that the water level could readily be seen from above. At the mouth of the bottle, the glass tube passed through two rubber stoppers, the one a two-holed stopper inserted in the bottle, and the other with its large end down, covering the hole, and preventing the entrance of water, but allowing free access of air. A file mark near the top of the bottle indicated the point to which the water level was raised on refilling. Throughout the experiment only distilled water, containing a small per cent of formaldehyde, was used.

The interior of the cup remains free from air because of the surface tension of the water films closing the pores. The cup thus remains filled with water, and as evaporation takes place at the surface, more water is forced up from below into the vacuum by the air pressure upon the water surface in the reservoir.

The porous cups used in this work were obtained through Dr. Dachnowski from the Carnegie Institute and were standardized at the Desert Laboratory at Tucson.

When used during the growing period of plants, the principal defect of this instrument is that rain may enter the reservoir through the porous cup, and thus cause an error in the results. If daily readings are taken, the length of time of precipitation can be recorded, and corrections made for the error. But in taking readings at intervals longer than a day, this error must be neglected.

One instrument was placed in a station of the Maple-Alder zone near the border of the island and was shaded by Acer rubrum, Alnus rugosa, and Rhus vernix. Osmunda cinnamomia, O. regalis, and Dryopteris cristata were growing nearby. The other station was in the central zone, where the principal plants were Sphagnum, Oxycoccus oxycoccus, Drosera rotundifolia, Eriophorum virginicum, and Dulichium arundinaceum.

Readings were begun May 14, and taken weekly until June 11. No data were taken then until July 17, when the evaporation for five weeks was recorded. Weekly readings were then resumed and taken until August 21, when after another break of three

weeks, they were continued until Oct. 2. Unfortunately, the instrument in the central zone was disturbed on August 21, and on September 11, had disappeared entirely. Temperature readings were also taken in the two zones.

FIG. 1. Central Zone Station.

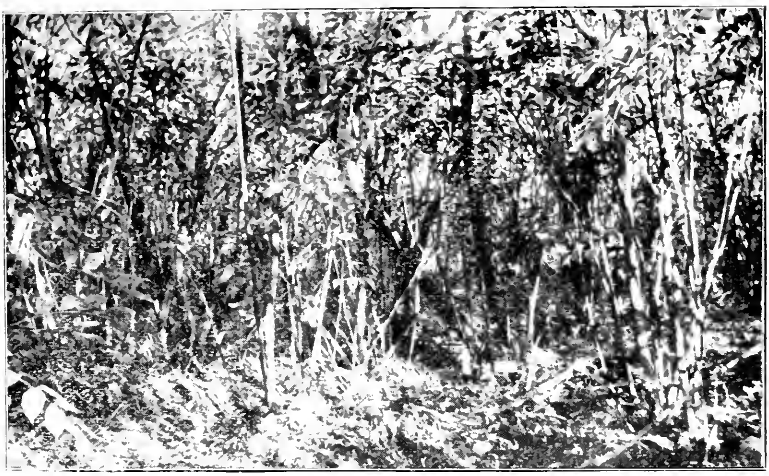

FIG. 2. Station in Maple-Alder Zone.

It was thought that an average of the precipitation and temperature records taken at the stations of the Weather Bureau at Pataskala, Gratiot, and Granville, would represent, approximately, the meteorology of our station at the bog. The records of wind velocity which are necessary to make the observations complete were not obtainable.

The climatology and evaporation data for the bog station are given in the table below:

TABLE I. CLIMATOLOGICAL AND EVAPORATION DATA FOR THE BOG ISLAND AT BUCKEYE LAKE, OHIO.

	Precip.		Temperature in F.					Sunshine			Evaporation		
Date	Precipitation	No. of days of .01 or more rainfall	Mean	Maximum	Minimum	Temperature in Maple-Alder Zone	Temperature in the Central Zone	Days clear	Days cloudy	Days partly cloudy	Maple-Alder Zone	Central Zone	Difference
1909 May 14	....	....	....	....	....	77.	75.2	....	....	....	....	....	....
May 21	1.07	2	64.5	82.	44.5	59.	60.	4	1	2	80.8	98.9	18.1
May 28	1.84	3	59.5	75.5	45.5	69.8	69.8	1	2	4	78.1	97.	18.9
June 4	2.04	5	67.5	84.5	50.5	73.4	78.8	2	2	3	60.5	92.1	31.6
June 11	.87	6	70.5	84.	52.5	77.	78.8	1	2	4	27.5	53.3	25.8
June 19	.25	2	66.	80.	47.	....	....	4	1	3			
June 26	2.30	4	70.5	87.5	43.	....	....	2	1	4			
July 3	1.00	2	77.	90.	59.	....	....	3	....	4	290.4	349.2	58.8
July 10	.02	2	66.6	85.5	46.5	....	....	3	2	2			
July 17	1.91	4	74.	87.	60.	76.1	75.2	1	2	4			
July 24	.46	2	67.	87.	46.	74.3	77.	4	1	2	77.	120.2	43.2
July 31	1.31	3	71.5	88.	51.	82.4	82.4	3	2	2	50.6	69.8	19.2
Aug. 7	.67	2	71.1	85.	55.	82.4	84.2	4	1	2	36.3	69.8	33.5
Aug. 14	.01	1	71.5	90.	53.	80.6	82.4	5	1	1	70.4	82.4	12.
Aug. 21	3.27	2	70.	85.	50.	72.5	72.5	2	1	4	38.5	..	....
Aug. 28	.10	1	69.5	89.	46.5	....	....	5	....	2			
Sept. 4	1.23	3	63.	86.	37.5	....	....	4	1	2	192.5	....	....
Sept. 11	.57	1	64.	79.5	42.	77.	80.6	3	....	4			
Sept. 18	.46	1	68.5	86.	46.	73.4	75.2	5	....	2	38.5	....	....
Sept. 25	.33	2	66.5	83.	46.	67.1	68.	3	....	4	82.5	....	....
Oct. 2	.23	2	53.	71.	33.	63.5	63.5	4	1	2	88.	....	....

An inspection of this table shows that rainfall has had the most marked effect upon the evaporation rate in the Maple-Alder zone, but it is very evident also that this was not the only factor. The influence of temperature in either station is not so apparent for so limited a number of readings. It is quite probable that the missing data for wind velocity would account for some of the results which do not seem to agree with the data at hand.

The effect of the growth of the leaves in the early part of the season, and their fall at the end of the period of observation is quite apparent in the readings of the Maple-Alder zone. The readings of the first and last two weeks in this zone are relatively high. If we consider the time from May to August as the critical period for growth and reproduction in plants, then the greatest evaporation observed is that of May 21 in the Maple-Alder zone, while the greatest loss in the Central zone occurred during the week ending July 24. However, the bearing of these data to plant growth in bogs will be discussed elsewhere.

To Prof. A. Dachnowski, under whose direction this work was planned and carried out, I wish to express here, my sincere appreciation for many helpful suggestions. I also wish to acknowledge the aid of a grant from the McMillin Research Fund, to cover the expenses of the field work.

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THE ORCHIDS OF OHIO.

Kate R. Blair.

People in general know little of orchids because they do not come in one's way as plants ordinarily do but must be sought for. They are most widely distributed in the damp and wooded regions of the world, reaching their greatest development in the tropics where many of them are brilliantly flowered epiphytes. In temperate regions they are terrestrial plants drawing their nourishment directly or indirectly from the soil. They are perennial herbs, many with root mycorrhizas, and on this account some of them are without green foliage leaves, depending entirely for their food supply on the fungus growing on their roots. Most of them are rare plants and grow only in special habitats, and because of their mutualistic habits they can not easily be raised in gardens since it is difficult to produce a suitable substratum in which the fungus can develop.

Twenty-one genera and thirty-seven species of orchids are reported from Ohio with two or three others that are doubtful. The species most widely distributed are: Galeorchis spectabilis, Aplectrum spicatum, Blephariglottis psycodes, Gyrostachys cernua, Limodorum tuberosum, Perularia flava, Pogonia ophioglossoides, Triphora trianthophora, and Blephariglottis lacera.

Orchids are valued chiefly because they are beautiful though a few are also useful. Vanilla is extracted from the fruit of a climbing orchid in Mexico; and the leaves of some species in Madagascar are used for making tea. Their flowers are among the most unique in the plant kingdom, and the parts are highly specialized, with peculiar adaptations for insect pollination. Among the Ohio genera having some species with showy flowers the following deserve mention: Cypripedium, Galeorchis, Blephariglottis, Arethusa, Pogonia and Leptorchis. Some of the Cypripediums are known to be poisonous to the touch. C. reginae is poisonous to the skin much like poison ivy. At least fifty per cent of people are susceptible. C. parviflorum is also poisonous but less so than the former, while the variety, hirsutum, is said to be as poisonous as C. reginae.

Orchidaceae. Orchid Family.

Perennial plants, commonly succulent, arising from bulbs or corms, or from fibrous or tuberous roots, with entire, often grass-like or bract-like leaves.

Flowers perfect, solitary, or in spikes or racemes, epigynous, zygomorphic, pentacylic, of a modified trimerous type, with a unilocular ovulary, specialized pollen masses, and numerous ovules on three parietal placentae; one of the petals usually

larger and of different form than the others, often spurred, and called the lip; fertile stamens one or two, variously united with the style into an unsymmetrical column; seeds numerous and minute.

KEY TO THE OHIO GENERA.

1. Anthers 2, one on each side of the style, with a trowel-shaped body on the upper side; lip a large inflated sac......... **Cypripedium**
1. Anthers 1, lip not a large inflated sac.......................... 2
2. Leaves 5, whorled, on a long stalk, flowers terminal; lip spurless; pollen mass powdery-granular......................... **Isotria**
2. Leaves not whorled though they may be opposite................ 3
3. Leaves broad in a basal rosette white reticulated, the flowering stems with bracts, the flowers in bracted spikes............ **Peramium**
3. Flowering stem with one well developed leaf (not grass-like) at about the middle.. 4
3. Stems with several leaves, or leafless; if with basal leaves, then not in a rosette.. 5
4. Flowers large, 1 or 2.................................. **Pogonia**
4. Flowers small, numerous, in a terminal raceme .... **Achroanthes**
5. Flowers single, rose-purple, the lip crested with hairs; leaves linear or reduced to bracts.............................. **Arethusa**
5. Flowers several or numerous.................................. 6
6. With 1 or 2 prominent basal leaves, the stem leaves reduced to bracts, or with all the leaves bract-like...................... 7
6. With normal leaves on the stem............................ 12
7. With 1 or 2 basal foliage leaves.............................. 8
7. Leaves all reduced to bracts................................. 11
8. With 2 basal leaves.. 9
8. With 1 basal leaf... 10
9. Flowers in a short loose spike with large leaf-like bracts surpassing them, violet-purple mixed with lighter purple and white; lip entire, produced below into a spur................. **Galeorchis**
9. Flowers in a long loose spike, greenish or white, bracts large, nearly equalling the flower; lip linear, or nearly so, spur long and slender .... **Lysias**
9. Flowers in terminal racemes, brownish-purple or yellowish-green, the subtending bracts minute and scale-like; lip flat, entire, not spurred. .... **Leptorchis**
10. Flowers in a terminal raceme, the pedicels subtended by small bracts; flowers not spurred.............................. **Aplectrum**
10. Flowers in a long loose raceme, nodding, bractless; flowers long-spurred .... **Tipularia**
11. Flowers in a spike, without spurs, white, greenish, or yellowish. .... **Gyrostachys**
11. Flowers in a raceme, with short spurs, dull purplish, or whitish mottled with crimson.................................. **Corallorhiza**
12. Flowering stem with a single large grass-like leaf; flowers large, 4–10. .... **Limodorum**
12. Flowering stem with several prominent leaves.................. 13
13. Leaves not much longer than broad; flowers few, axillary, pale purple, the lip spurless.................................... **Triphora**
13. Leaves all much longer than broad.......................... 14
14. Flowers spiked, small, greenish, without a spur, leaves mostly narrow or bract-like .... **Gyrostachys**
14. Flowers with a spur.. 15
15. Lip of the corolla fringed or parted and cut-toothed; spike with foliaceous bracts............................ **Blephariglottis**

15. Lip not fringed nor cut-toothed, flowers greenish or whitish......16
16. With one large and a much smaller leaf besides smaller bracts on the stem; beak of the stigma with 3 oblong or clavate appendages. ....**Gymnandeniopsis**
16. With several large leaves on the stem...........................17
17. Spur slender, straight, longer than the lip; lip hastate, with a tubercle at the base...**Perularia**
17. Spur much shorter than the lip, blunt, sac-like; lip 3-toothed at apex. .... **Coeloglossum**
17. Spur seldom equalling the lip, blunt slightly incurved, decidedly clavate; lip lanceolate, entire........................**Limnorchis**

Cypripedium L.

Glandular pubescent herbs, with leafy stems or scapes, and thick tufted roots. Leaves large, broad, many-nerved. Flowers large, showy, solitary or several. Sepals spreading, separate, or two of them united. Lip a large inflated sac. Column declined, bearing a sessile or stalked anther on each side, and a dilated sterile stamen above, which covers the summit of the style. Pollen masses granular, without a caudicle or gland. Stigma terminal, broad, somewhat 3-lobed.

1. Plant 2-leaved, scape 1-flowered, lip fissured in front ......**C. acaule**
1. Stem leafy to the top, 1-several flowered, lip not fissured in front, but with a rounded, open orifice.................................2
2. Sepals and linear twisted petals acute, longer than the lip..........3
2. Sepals and petals not twisted, shorter than the lip or nearly equalling it. .... **C. reginae**
3. Lip white, sterile stamen lanceolate..................**C. candidum**
3. Lip yellow, sterile stamen triangular................**C. parviflorum**

1. **Cypripedium acaule** Ait. Stemless Lady's-slipper. Stem 16 in. high, very pubescent; leaves 2, basal, 10–20 in. long, 4–8 in. wide, sparsely pubescent; sepals greenish-purple; petals pink with darker veins, or sometimes white. A low plant with 2 large leaves and a showy, fragrant flower, growing in sandy or rocky woods. Medina, Portage, Hocking, Fairfield, Stark and Cuyahoga Counties.

2. **Cypripedium reginae** Walt. Showy Lady's-slipper. Stem 2 ft. high, very pubescent, leafy to the top; leaves elliptic, acute, 5–7 in. long, 2–5 in. wide; flowers 1–3; lip much inflated, over 1 in. long, variegated with purple and white stripes. A tall leafy plant with showy flowers growing in swamps and woods. Fulton, Champaign, Lucas, Geauga, Portage, and Muskingum Counties.

3. **Cypripedium candidum** Willd. Small White Lady's-slipper. Stem 4–12 in. high, slightly pubescent, leafy; leaves 3 or 4, elliptic or lanceolate, acute or acuminate, 3–5 in. long; bracts 1–2 in. long, lanceolate; flowers solitary; lip white, striped with purple inside, about 1 in. long. A small plant with showy flower, growing in bogs and meadows. Wyandot and Erie Counties.

4. **Cypripedium parviflorum** Salisb. Small Yellow Lady's-slipper. Stem 1–2 ft. high, pubescent, leafy; leaves 5, oval, elliptic, or lanceolate, 2–6 in. long; flower solitary; lip golden yellow, $\frac{3}{4}$–$1\frac{1}{4}$ in. long, purple spotted. Grows in woods and thickets. Lorain, Cuyahoga, Geauga, Stark, Montgomery, Clarke, Franklin and Gallia Counties.

The variety known as **Cypripedium hirsutum** Mill., Large Yellow Lady's-slipper, is a tall showy plant with leafy stem and larger flower than C. parviflorum, with pale yellow lip $1\frac{1}{2}$–2 in. long. In woods and thickets. Fulton, Lucas, Wyandot, Medina, Portage, Auglaize, Champaign, Licking, and Gallia Counties.

Galeorchis Rydb.

Rhizome very short with numerous fleshy roots; stem scape-like with 2 large round leaves at the base; flowers in a short loose spike with large leaf-like bracts surpassing them; lip entire, wavy, produced below into a spur.

1. **Galeorchis spectabilis** (L.) Rydb. Showy Orchis. Stem 4–12 in. high, fleshy, 5-angled; leaves with 1 or 2 scales below them, sometimes 8 in. long and 4 in. wide, but usually smaller, clammy to the touch; flowers in a short loose spike with large leaf-like bracts surpassing them, violet-purple mixed with lighter purple and white; lip whitish, divergent, entire, about as long as the petals. A plant with 2 large leaves surpassing the stem and a spike of showy flowers. Grows in rich woods. Defiance, Sandusky, Cuyahoga, Medina, Portage, Wyandot, Stark, Columbiana, Miami, Clarke, Franklin, Licking, Greene, Fairfield, Clinton, Ross, Vinton, Hamilton, Clermont, and Gallia Counties.

Perularia Lindl.

Plant leafy-stemmed with a cluster of thick fibrous roots; flowers small, greenish, in a long open spike with long bracts; lip lanceolate with a tooth on each side at the base and a central tubercle at the middle of the base; spur slender, straight, longer than the lip, but shorter than the ovulary.

1. **Perularia flava** (L.) Rydb. Tubercled Orchis. Stem smooth, bracted, 12–24 in. high, stout, leafy; leaves lanceolate or elliptic, acute or obtuse, 4–12 long; flowers greenish, in a long open spike with long bracts; lip lanceolate, with a tooth on each side at the base, and a central tubercle at the middle of the base. A sturdy plant with a leafy stem and small pale green flowers, growing in moist soil. Erie, Cuyahoga, Huron, Lake, Crawford, Knox, Franklin, and Gallia Counties

Coeloglossum Hartman.

Leafy plants with biennial 2-cleft tubers; flowers greenish, in a long, leafy-bracted spike; lip oblong, obtuse, 2–3 toothed at the apex; spur much shorter than the lip. blunt, sac-like.

1. **Coeloglossum bracteatum** (Willd.) Parl. Long-bracted Orchis. Stem leafy, 6–24 in. high; leaves lanceolate, ovate or oval, or the lowest sometimes obovate, 2–7 in. long, the upper much smaller; bracts longer than the ovularies; flowers green or greenish; lip ½–¾ in. long, 2–3 toothed or lobed at the apex. A tall sturdy plant with leafy stem and a spike of greenish flowers. Growing in woods and meadows. Lucas, Lorain, Medina, Portage, Franklin, Butler, and Auglaize Counties.

Gymnandeniopsis Rydb.

Leafy plants with fleshy, fibrous, or somewhat tuberous roots, and a short spike of small flowers; lip entire or 3-toothed at the apex, much exceeded by the long filiform or clavate spur.

1. **Gymnandeniopsis clavellata** (Mx.) Rydb. Small Green Wood Orchis. Stem 8–20 in. high, angled, 1-leaved near the base, with several small bract-like leaves above, one of which is larger; basal leaf oblanceolate, 4–6 in. long; flowers in a spike ½–1 in. long, small, greenish or whitish; lip dilated and 3-toothed at the apex. A tall slender plant with one leaf, growing in moist shady places. Geauga, Trumbull, Portage, Summit, Licking, and Champaign Counties.

Limnorchis Rydb.

Leafy plants with thick fleshy roots and small greenish or whitish flowers in a long spike; lip entire; beak of the stigma without appendages.

1. **Limnorchis hyperborea** (L.) Rydb. Tall Bog-orchis. A stout stem, 8–24 in. high; lanceolate leaves 2–12 in, long; greenish yellow flowers in a narrow spike; lip lanceolate, entire, obtuse. A tall plant with thick fleshy roots, growing in bogs and wet woods. Stark County.

Lysias Salisb.

Plants with scapose stems, tuberous or fleshy roots, and 2 basal leaves; flowers greenish or white; lip entire, linear or nearly so; spur long and slender, generally longer than the elongated straight ovulary.

1. Scape with 1 or more bracts; flowers in a loose raceme. . **L. orbiculata**
1. Scape bractless; flowers in a strict, rather dense raceme. . **L. hookeriana**

1. **Lysias orbiculata** (Pursh.) Rydb. Large Round-leaf Orchis. Stems 12–24 in. high, bracted; leaves orbicular, spreading flat on the ground, 4–7 in. long; flowers in a loosely many-flowered raceme, greenish white; lip ½ in. long. A tall slender plant with a raceme of greenish white flowers on a scape, much surpassing the leaves. Growing in rich woods. Cuyahoga and Geauga Counties.

2. **Lysias hookeriana** (Gr.)Rydb. Hooker's Orchis. Stem 8–16 in. high, not bracted; leaves orbicular, oval, or obovate, fleshy, shiny, spreading or ascending, 4–7 in. long; flowers in a rather loosely many-flowered raceme, yellowish green; lip linear-lanceolate, 3–4 in. long; flowers in a spike 3–6 in. long, greenish; lip 2–3 in. long, 2–3 toothed or lobed at the apex. A sturdier plant than the preceding with a closer raceme and thicker leaves. Medina County.

Blephariglottis Raf.

Plants with tall leafy stems and fleshy or tuberous roots; flowers several or numerous, in an open spike with foliaceous bracts; corolla white, yellow, or purplish; lip variously fringed or 3-parted and cut toothed; spur longer than the lip.

1. Lip not divided or 3 parted, fringed 2
1. Lip 3-parted, the divisions toothed or fringed 3
2. Flowers orange or yellow, lip oblong . . . . **B. ciliaris**
2. Flowers white, lip narrowly ovate-lanceolate . . . . . **B. blephariglottis**
3. Flowers greenish yellow or white 4
3. Flowers violet or purplish 5
4. Flowers greenish yellow; petals entire, fringe of a few threads . . **B. lacera**
4. Flowers white; petals minutely cut-toothed, fringe copious . . . . **B. leucophaea**
5. Segments of the lip deeply fringed . . . . **B. psycodes**
5. Segments of the lip cut-toothed . . . . **B. peramoena**

1. **Blephariglottis ciliaris** (L.) Rydb. Yellow Fringed-orchis. Stem 16–28 in. high, slender, smooth, bracted; leaves lanceolate, acute, 4–8 in. long, the upper smaller; flowers orange or yellow, large, showy, in a close many-flowered spike; lip 5–7 lines long, copiously fringed more than half way to the middle. A tall slender plant with showy yellow-fringed flowers, growing in meadows. Fulton County.
2. **Blephariglottis blephariglottis** (Willd.) Rydb. White Fringed-orchis. Leaves more slender than in the preceding species; flowers pure white, somewhat smaller than those of preceding species, in a densely or rather loosely many-flowered spike; lip narrow, oblong, copiously or sparsely fringed. A tall plant with white fringed flowers, growing in bogs or swamps. Geauga and Portage Counties.
3. **Blephariglottis lacera** (Mx.) Rydb. Ragged Orchis. Stem rather slender, bracted, leafy, 12–24 in. high; leaves firm, lanceolate, 4½–8 in. long, the upper gradually smaller; flowers greenish yellow in a long loose spike; segments of the lip narrow, deeply fringed, the fringe of a few threads about ½ in. long. A tall slender plant with a ragged looking spike of greenish yellow flowers, growing in swamps and wet woods. Cuyahoga, Portage, Crawford, Wayne, Stark, Licking, and Fairfield Counties.

4. **Blephariglottis leucophaea** (Nutt.) Rydb. Prairie White Fringed-orchis. Stem stout, angled, 20–32 in. high; leaves lanceolate, 4–8 in. long; flowers large, white, fragrant, sometimes tinged with green, in a very thick loosely-flowered spike, 3–4½ in. long; lip 6–7 lines long, the segments broadly wedge-shaped and copiously fringed. A tall plant with white fragrant flowers growing on moist prairies. Auglaize County.
5. **Blephariglottis psycodes** (L.) Rydb. Smaller Purple Fringed-orchis. Stem rather slender, 12–40 in. high; leaves oval, elliptic, or lanceolate, 2–10 in. long; flowers lilac, rarely white, fragrant, in a loosely or densely many-flowered raceme; lip, $3\frac{1}{6}$–$4\frac{1}{6}$ in. broad, the segments fan-shaped and copiously fringed. A tall showy plant growing in meadows and wet woods. Medina, Erie, Cuyahoga, Ashtabula, Miami, Columbiana, Richland, Auglaize, Franklin, and Hocking Counties.
6. **Blephariglottis peramoena** (Gr.) Rydb. Fringeless Purple Orchis. Stem 12–28 in. high; leaves elliptic or lanceolate, 4–8 in. long, the upper gradually smaller; flowers large, showy, violet-purple, in a densely or rather loosely many-flowered spike; lip 7–9 lines long, the segments fan-shaped, cut-toothed, not fringed, the middle one 2-lobed. A tall showy plant growing in moist meadows. Perry, Gallia, and Clermont Counties.

Pogonia Juss.

Mostly low herbs with slender rhizomes, fibrous roots, alternate leaves, and solitary terminal flowers; lip erect from the base of the column, spurless, crested.

1. **Pogonia ophioglossoides** (L.) Ker. Rose Pogonia. Stem 12–15¼ in. high, 1–3 leaved, not rarely with a long-petioled basal leaf; leaves 1–10 in. long, lanceolate or ovate, erect, bluntly acute; flowers pale rose-color, fragrant, slightly nodding, solitary or occasionally in pairs, subtended by a foliaceous bract; lip 2–3 lines wide, fringed. A striking looking plant with rose-colored flowers, growing in meadows and swamps. Lucas, Cuyahoga, Geauga, Ashland, Portage, Licking and Lorain Counties.

Isotria Raf.

Low herbs, with a rhizome, fibrous roots, terminal flowers, and 5 leaves in a whorl near the top of the plant; lip erect from the base of the column, crested, spurless, sessile.

1. **Isotria verticellata** (Willd.) Raf. Whorled Isotria. Stem 10–12 in. high, from long fleshy roots; leaves 3¼–2¼ in. long, obovate, abruptly pointed at apex, sessile; flower sol-

itary, erect or declined, peduncled; lip 3-lobed, crested along a narrow band, undulate. A tall plant with a conspicuous whorl of leaves near the top, growing in moist woods. Defiance, Cuyahoga, Geauga, Medina, Coshocton, and Fairfield Counties.

Triphora Nutt.

Low herbs with fleshy tubers and axillary flowers; lip erect, slightly clawed, and more or less 3-lobed, not crested, spurless; capsule oval, drooping.

1. **Triphora trianthophora** (Sw.) Rydb. Nodding Triphora. Stem glabrous, 3–12 in. high, from a tuberous root; leaves 2–8, alternate, ovate, 3–9 lines long, clasping; flowers 1–7, axillary, peduncled, pale purple, at first nearly erect, soon drooping; lip clawed, somewhat 3-lobed, crisped above, about as long as the petals. A slender, delicate plant, with nodding flower, growing in rich woods. Huron, Cuyahoga, Summit, Stark, Licking, Franklin and Ross Counties.

Arethusa L.

Low herbs with small bulbs and mostly solitary flowers on slender scapes, the solitary leaf linear, hidden at first in the upper scale, protruding after flowering; lip dilated, recurved and spreading at the apex, crested on the face with straight somewhat fleshy hairs, slightly gibbous at the base.

1. **Arethusa bulbosa** L. Arethusa. Stem, scapose, 4–12 in. high, bearing 1–3 loose sheathing bracts; leaf linear, many-nerved, 4–6 in. long; flower rose-purple, solitary (rarely 2), $\frac{3}{4}$–2 in. long; lip usually drooping beneath the sepals and petals, the apex broad, rounded, variegated with purple blotches. A low plant with a conspicuous flower, and 1 leaf, growing in bogs. Licking and Portage Counties.

Limodorum L.

Scapose herbs with solid round bulbs which arise from the bulb of the previous year, a leaf appearing the first season succeeded in the following year by the scape; flowers several, in a loose terminal spike or raceme; lip spreading, raised on a narrow stalk, dilated at the apex; bearded on the upper side with long club-shaped hairs.

1. **Limodorum tuberosum** L. Calopogon. Scape slender, naked, 12–33$\frac{1}{2}$ in. high; leaf linear-lanceolate, 8–12 in. long, 3–12 lines wide, sheathing, with several scales below it; spike 4–16 in. long, 3–15 flowered; lip as long as the column, broadly triangular at the apex. A tall plant with showy, purplish-pink flowers, and one grass-like leaf, growing in bogs and meadows. Fulton, Lucas, Erie, Geauga, Portage, Summit, Ashland, Stark, Clarke, Fairfield and Licking Counties.

Gyrostachys Pers.

Erect herbs with fleshy fibrous or tuberous roots and slender stems or scapes, leafy below or at the base; flowers small, spurless, spiked, 1–3 rowed, the spikes more or less twisted; the lip sessile or clawed, concave, erect, embracing the column and often adhering to it, bearing minute callosities at the base.

1. Flowers apparently in several ranks, stems not twisted, or but slightly so 2
1. Flowers merely alternate, often secund from the spiral twisting of the stem. 4
2. Sepals and petals more or less connivent into a hood, leaves linear or linear-lanceolate . . . . **G. stricta**
2. Lateral sepals separate, free 3
3. Spike short, about 2 in. or less; leaves rather broad, oblong-lanceolate; callosities none, or mere thickenings of the basal margins of the lip . . . . **G. plantaginea**
3. Spike long, 3–6 in.; leaves linear to linear-oblanceolate; callosities of the lip nipple-shaped . . . . **G. cernua**
4. Stem leafy lower leaves elongated, outer sepals lanceolate. . **G. praecox**
4. Stem with scaly bracts, leaves if present basal 5
5. Root a single tuber; spike about 1–1½ in. long . . . . **G. simplex**
5. Root usually a cluster of tubers; spike 1–3 in. long . . . . . . **G. gracilis**

1. **Gyrostachys stricta** Rydb. Hooded Lady's-tresses. Stem 6–14 in. high, leafy below, bracted above; leaves 2¾–8 in. long, linear; flowers in a spike 2–4 in. long, spreading horizontally; lip oblong, crisped at apex, thin and transparent. A bare looking plant, with a loose spike of fragrant flowers, growing in bogs. Ashtabula County.

2. **Gyrostachys plantaginea** (Raf.) Britt. Wide-leaf Lady's-tresses. Stem 4–10 in. high, glabrous or pubescent, bearing 4 or 5 lanceolate or oblanceolate leaves below; leaves 1–5 in. long; flowers in a thick, dense spike, 1–2 in. long, 4–6 lines thick; flowers spreading, white; lip, pale yellow on the face, oblong, the wavy apex rounded, crispate or fringed, the base short-clawed. A small plant with basal leaves, growing on moist banks and in woods, Medina and Portage Counties.

3. **Gyrostachys cernua** (L.) Ktz. Nodding Lady's-tresses. Stem 8–24 in. high (rarely higher), usually pubescent above, bearing 2–6 bract-like stem leaves; basal leaves from linear-oblanceolate to linear, 2¾–12¼ in. long, the blade narrow; flowers in a thick spike, 4–4½ in. long, 5–6 lines thick; flowers white, nodding or spreading, about 5 lines long; lip oblong or ovate, the apex rounded and crisped. A tall showy plant with nodding, fragrant flowers, growing in meadows and swamps. Erie, Lorain, Cuyahoga, Medina, Portage, Stark, Lake, Licking, Fulton, Clermont and Gallia Counties.

4. **Gyrostachys praecox** (Walt.) Ktz. Grass-leaf Lady's-tresses. Stem, 10–24 in. high, leafy; leaves linear, 4–12 in. long, with narrow grass-like blades and long sheathing petioles, per-

sistent through flowering season, the upper smaller; flowers in a twisted spike 2–8 in. long, 4–10 lines thick; lip about 3 lines long, crenulate, short-clawed, dark-striped in the middle. A tall showy plant growing in grassy places. Wayne County.

5. **Gyrostachys simplex** (Gr.) Ktz. Little Lady's-tresses. Stem very slender 5–8 in. high, rising from a solitary spindle-shaped tuber, with small deciduous bracts above; leaves basal, oblong, petiolate, mostly disappearing at or before flowering time; flowers white, in a slender spike, slightly twisted, 9–14 lines long; lip thin, short clawed, crisped at summit. A bare, delicate plant, growing in sandy soil. Fairfield County.

6. **Gyrostachys gracilis** (Bigel) Ktz. Slender Lady's-tresses. Stem 8–24 in. high, slender, rising from a cluster of spindle-shaped, tuberous roots, bearing small deciduous bracts; leaves basal, obovate, or ovate-lanceolate, disappearing mostly before the flowering season; flowers white, in a spike 1–5 in. long, much twisted; lip 2 lines long, wavy, thick and green in the middle. A tall bare plant in dry fields and open woods. Erie, Cuyahoga, Lake, Licking, Muskingum, Fairfield, Adams, Gallia, and Morgan Counties.

Peramium Salisb.

Herbs with bracted, erect scapes; thick, fleshy, fibrous roots, and basal tufted leaves often blotched with white; flowers in bracted spikes; lip sessile, entire, roundish ovate, concave or saccate, without callosities, its apex reflexed.

1. **Peramium pubescens** (Willd.) MacM. Downy Rattlesnake Plantain. Stem densely glandular-pubescent, bearing 5–10 lanceolate scales, 6–24 in. high; leaves basal, $^3/_4$–1 in. long, strongly white-reticulated, oval or ovate; flowers in a dense spike, not 1-sided; lip strongly saccate with a short broad recurved or spreading tip. A sturdy plant with conspicuous flowers and showy leaves, growing in dry woods. Adams, Hocking, Lake, Portage, Fairfield and Highland Counties.

Achroanthes Raf.

Low herbs from a solid bulb, our species with 1 leaf and with 1-several scales at the base of the stem; flowers small, white or green, in a terminal raceme; lip cordate or eared at the base, embracing the column.

1. Pedicels nearly equal to the ovularies in length; lip terminating in a long point. (Doubtful for the state) .... **A. monophylla**
1. Pedicels much longer than the ovularies, lip truncate, 3-lobed at the summit .... **A. unifolia**

1. **Achroanthes unifolia** (Mx.) Raf. Green Adder's-mouth. Stem 4–10 in. high, striate; leaf clasping the stem near the middle, oval or nearly orbicular; raceme $^3/_4$–3 in. long of

spreading flowers with slender pedicels; lip broad, 2-lobed at the apex, with a small tooth in the sinus. A slender plant with raceme of delicate flowers growing in woods and thickets. Fairfield County.

Leptorchis Thouars.

Low herbs with solid bulbs, the base of the stem sheathed by several scales and 2 broad, shining leaves, flowers in a terminal raceme; lip nearly flat, often bearing 2 tubercles above the base.

1. Lip brownish-purple, $\frac{3}{8}$–$\frac{1}{2}$ in. long; raceme loose-flowered, 1–2 in. wide .... **L. liliifolia**
1. Lip yellowish-green, $\frac{1}{8}$–$\frac{1}{4}$ in. long; raceme compact, about $\frac{1}{2}$ in. wide. .... **L. loeselii**

1. **Leptorchis liliifolia** (L.) Ktz. Large Twayblade. Stem a scape, striate, 4–10 in. high; leaves 2–$4\frac{3}{4}$ in. long, oval or ovate, keeled below; numerous showy flowers, in a raceme sometimes 6 in. long; lip conspicuous, erect, 5–6 lines long, wedge-obovate. A delicate showy plant, growing in moist woods and thickets. Portage, Franklin, Fairfield and Clarke Counties.

2. **Leptorchis loeselii** (L.) MacM. Fen Twayblade. Scape 2–8 in. high, strongly ribbed; leaves elliptic or elliptic-lanceolate, 2–6 in. long; flowers few, greenish, smaller than the preceding, in a raceme; lip obovate, pointed, its tip incurved. A tall plant, with greenish inconspicuous flowers, in wet thickets and on springy banks. Champaign, Cuyahoga, Summit, and Stark Counties.

Tipularia Nutt.

Slender scapose herbs with solid bulbs, several generations connected by offsets; the flowers in a long, loose, terminal raceme; leaf solitary, basal, unfolding long after the flowering season, usually after the scape has perished; scape with several thin sheathing scales at the base; flowers green, nodding, bractless; lip 3-lobed with a long slender spur.

1. **Tipularia unifolia** (Muhl.) B. S. P. Crane-fly Orchis. Scape glabrous 16–20 in. high, from a hard, often irregular corm; leaf arising in Autumn from a fresh lateral corm, ovate, 2–$2\frac{3}{4}$ in. long, dark green; raceme 5–9 in. long, very loose, flowers green tinged with purple; lip mostly shorter than the petals, the middle lobes narrow, prolonged, dilated at the apex, the lateral lobes short, triangular; spur often twice as long as the flower. A tall slender plant with a loose raceme of nodding flowers, growing in woods. Lorain, and Cuyahoga Counties (Oberlin College.)

Aplectrum Nutt.

Scapose herbs from a corm, produced from the one of the previous season by an offset and sometimes with coralloid fibres, the scape clothed with several sheathing scales; leaf solitary,

basal, broad petioled, developed in autumn or late summer; flowers in a terminal raceme, the pedicels subtended by small bracts; lip clawed, somewhat 3-ridged, spur none.

1. **Aplectrum spicatum** (Walt.) B. S. P. Putty-root. Scape glabrous, 12–24 in. high, bearing about 3 sheathing scales; leaf arising from the corm, at the side of the scape, 4–6½ in. long, 1–2½ in. wide, usually lasting over winter; raceme 2–4 in. long, loosely several-flowered; lip shorter than the petals, obtuse, somewhat 3-lobed and undulate. A tall plant with yellowish brown or green flowers, with 1 broad leaf that usually lasts over winter, growing in woods and swamps. Hamilton, Green, Montgomery, Preble, Stark, Adams, Warren, Portage, Auglaize, Sandusky, Franklin, Lake, Clermont, Gallia, Erie and Clarke Counties.

Corallorhiza R. Br.

Scapose herbs, with mycorrhiza or root parasites, with large masses of coralloid branching roots, the leaves all reduced to sheathing scales; flowers in terminal racemes; lip 1–3 ridged; sepals nearly equal, the lateral ones united at the base with the foot of the column forming a short spur or gibbous protuberance adnate to the summit of the ovulary.

1. Lip deeply 3-lobed, white, spotted with red............**C. multiflora**
1. Lip 2-toothed or 2-lobed above the base, white, not spotted. (No locality known) ....**C. corallorhiza**
1. Lip entire or merely denticulate.................................2
2. Flowers about ¼ in. long, lip whitish................**C. odontorhiza**
2. Flowers about ½ in. long, lip white, spotted with red...**C. wisteriana**

1. **Corallorhiza odontorhiza** (Willd.) Nutt. Small-flowered Coral-root. A purplish slender scape 6–14 in. high, bearing 3–5 sheathing scales; raceme 2–4 in. long, of 6–20 purplish flowers; lip, broadly oval or obovate, entire or denticulate, narrowed at the base, not notched. A bare looking plant growing under trees. Erie, Cuyahoga, Stark and Madison Counties.

2. **Corallorhiza wisteriana** Conrad. Wister's Coral-root. Stem 8–16 in. high, bearing several sheathing scales; raceme 2–4 in. long, loose, 6–15 flowered; lip broadly oval or obovate, 4–5 lines long and wide, abruptly clawed, white with crimson spots, crenulate, notched at the apex, spur a somewhat conspicuous protuberance adnate to the top of the ovulary. A tall stout plant with scaly stem growing in shady woods. Hamilton County (New York Botanical Gardens).

3. **Corallorhiza multiflora** Nutt. Large Coral-root. Stem 8–20 in. high, bearing several appressed scales, purplish; a raceme of brownish purple flowers with short pedicels; lip oval or ovate, deeply 3-lobed, the middle lobe broader than the lateral ones, its apex curved. A tall bare looking plant growing in woods. Erie, Huron, Fairfield and Franklin Counties.

LIST OF INSECTS AFFECTING THE MAPLE.

James F. Zimmer.

DIPTERA.

Cecidomyidae. Cecidomyia erubescens (O. S.), Cecidomyia ocellaris (Osten Sacken).

HYMENOPTERA.

Oryssidae. Cryssus terminalis (Newman), Oryssus Sayi. (Westwood.

Siricidae. Tremex columba. (Linn.).

Tenthredinoidea. Cimbex americana (Leach.).

Uroceridae. Xiphidria albicornis (Harris).

COLEOPTERA.

Calandridae. Stenoscelis brevis (Boh.).

Brenthidae. Eupsalis minuta (Drury).

Buprestidae. Dicerca divaricata (Say), Chrysobothris formorata (Fab.)

Cerambycidae. Graphisurus fasciatus (De Geer), Glycobinus speciosus (Say), Bellamira scalaris (Say), Monohammus marmoratus (Rand.), Purpuricenus humeralis (Fabr.), Elaphidion villosum (Fab.), Molorchus bimaculatus (Say.), Urographis fasciatus (De Geer), Liopus variegatus (Hald), Hyperplatys maculatus (Hald), Dryobius sexfasciatus (Say), Leptostylus oculiferus (Say.).

Chrysomelidae. Chrysomela bigsbyana (Kirby.).

Cleridae. Thaneroclerus sanguineus (Say.).

Coccinellidae. Anatis ocellata (Linn.).

Cucujidae. Silvanus imbeilis (Lec.), Laemophloeus biguttatus (Say.).

Elateridae. Elater humeralis (Lec.).

Histeridae. Hister lecontei (Say).

Hydrophilidae. Cerylon caslaneum (Say.).

Lucanidae. Ptalycerus quercus (Weber).

Melandryidae. Melandrya Striata (Say), Euchodes sericea (Hald.), Phloetrya liturata (Lec.), Synchroa punctata (Newm.).

Mordellidae. Mordella borealis.

Nitidulidae. Cryptarcha concinna (Melsh), Colastus truncatus (Rand.)

Ptinidae. Ptilinus ruficornis (Say.), Xeslobium affine (Lec.).

Scolytidae. Xyloterus politus (Say.), Corthylus punctatissimus (Linn.).

Tenebrionidae. Boletotherus bifurcus (Fab.).

HEMIPTERA.

Aphidae. Drepanosiphum acerfolii (Thos.), Chaitophorus aceris (Linn.).

Coccidae. Pulvinaria innumerabilus (Rathvon.), Eulecanium nigrofasciatum (Perg.), Aspidiotus abietis (Schr.), Asphidiotus Ancylus (Putnam), Aspidiotus Perniciosus (Com.), Phenacoccus acericola (King.).

Cicadidae. Tibicen pruniosa (Linn.).

Membracidae. Ceresa bubalus (Fabr.).

LEPIDOPTERA.

Aegeriadae. Aegeria acerni (Clemens.).

Anthribidae. Gonotropis gibbosus (Lec.), Cratoparis lunatus (Fabr.).

Bombycidae. Dryocampa rubicunda (Fabr.), Hyperchiria rubicunda (Fabr.), Telea polyphemus (Hubner), Lichocodes fasciola (H. Sch.), Chisocampa sylvatica (Harris.).

Ceratocampidae. Anisota rubicunda (Fabr.), (Eacles) Basilona imperialis (Drury).

Cossidae. Zeuzera pyrina (Linn.), Prionoxystus robiniae (Peck.), Sesia acerni (Clemens).

Cochlidiidae. Sisyrosea textula (Herrich-Schaeffer), Sisyrosea inornata (Grote and Rob.).

Cuculionidae. Cryplorhynchus obtentus (Hbst.).

Ennomidae. Ennomos magnarius (Guenеé.).

Eucleidae. Prolimacodes scapha (Harris.).

Geometridae. Ania limbata (Haw.), Selenia kentaria (Grote.).

Hepialidae. Hepialus argenteomaculatus (Harris).

Lasiocampidae. Clisiocampa disstria (Hubn.).

Lymantriidae. Notolophus leucostigma (Abbot & Smith).

Notodontidae. Heterocampa subrotata (Haw.), Edema albifrons (Abbot & Smith), Lochmaeus olivatus (Packard), Nadata gibbosa (Abbot and Smith), Symmerista albifrons (Abbot & Smith), Lochmaeus cinereus (Packard).

Nocteudae. Apatela americana (Harris).

Noctuidae. Apatela americana (Harris), Gortyna nitela (Harris), Porthetria dispar (Guen.), Euproctis chrysorrhoea (Linn.), Slegania pustularia (Guen.), Amphydasys cognataria (Guen.), Eutrapela transversata (Pack.), Xylina antennata (Walker.), Demas propinquilinea (Grote.), Papaipema nitela (Guen.), Ophinsa bistriaris (Hübner), Homoptera lunata (Drury.).

Orneodidae. Eulia velutinana (Walker), Tortricidia pallida (Herrick and Schaeffer).

Phalaenidae. Ennomos subsignarius (Hübner), Ectropis crepuscularia (Tr.).

Pyrochroidae. Dendroides canadensis (Latr.).
Psychidae. Thyridopleryx ephemeraeformis (Haw.).
Pyralidae. Hypena baltimoralis (Guen.).
Scolytidae. Monarthrum mali. (Fitch.).
Saturniidae. (Semia), Platysania cecropia (Linn.), Callosamia promethea (Drury).
Tenebrionidae. Hoplocephala bicornis. (Oliv.).
Tineidae. Gracilaria alchimiella. (Clem.).
Tortricidae. Proteoteras aesculanum (Riley), Cenopis reticulatana (Fitch.), Epinotia claypoleana (Riley), Thiodia signatana (Clem), Cacoecia rosaceana (Harris.).

ISOPTERA.

Termitidae. Termes flavipes (Koller.)

ARACHNIDA.

Erioplyes quadripes (Shimer.)
A Trichina parasite.

NEW AND RARE OHIO PLANTS.*

JOHN H. SCHAFFNER.

The following new and rare plants have been added to the state herbarium during the past year. Their position in the state catalog is indicated by the number preceding the species name.

2. **Botrychium simplex** Hitch. Little Grape-fern. Cedar Point, Erie Co., John H. Schaffner.

61. **Lycopodium inundatum** L. Bog Club-moss. Portage Co., L. S. Hopkins.

234a. **Cynosurus cristatus** L. Dogtail Grass. Ellsworth Station, Mahoning Co., Ernest W. Vickers.

254. **Festuca ovina** L. Sheep Fescue-grass. Cedar Point, Erie Co., John H. Schaffner.

781c. **Alsine aquatica** (L.) Britt. Water Chickweed. Eldon, Guernsey Co., Emma E. Laughlin.

901a. **Barbarea praecox** (J. E. Sm.) R. Br. Early Winter-cress. Barnesville, Belmont Co., Emma E. Laughlin.

939. **Koniga maritima** (L.) R. Br. Sweet Alyssum. Cedar Point, Erie Co., John H. Schaffner. A waif.

1143a. **Oxalis brittoniae** Small. Britton's Wood-sorrel. Columbus, Franklin Co., John H. Schaffner.

1143b. **Oxalis rufa** Small. Red Wood-sorrel. Columbus, Franklin Co., John H. Schaffner.

1379. **Ledum groenlandicum** Oeder. Labrador Tea. Shalersville, Portage Co., R. J. Webb and A. D. Robinson.

* Presented at the meeting of the Ohio Acad. of Sci.

A NEW LABORATORY GUIDE FOR HIGH SCHOOL BOTANY.

Under the title, "Laboratory Botany for the High School," Prof. Willard N. Clute has published, through Ginn & Company, a little volume that will be an important addition to the text-books intended for secondary schools. The author is a high school teacher as well as a practical botanist and the book before us shows that it is the outcome of a course adapted to the age and capacity of the students for which it is intended.

The one essential to a good high school course is that it should not ape the general course given to more mature students in the college. The high school has a field of its own.

"Laboratory Botany" can be used for a half year or a year course. The work is so arranged that a greater or less amount of an exercise can be taken without difficulty. The language is simple, which makes it easy for the student to concentrate attention on the necessary scientific terms. There are review questions and suggestions to the teacher that are very opportune. The definitions at the end of each chapter are perhaps one of the best features of the book. It is just such convenient lists that the beginner needs to consult.

The work begins with simple exercises on the living cell and is followed in order by chapters on seeds, roots, buds, stems, leaves, flowers, and fruits and seeds. The first part ends with a study of trees and the ecology of the flower. The first part will make a good half year course for the spring semester, although the author shows that it can easily be given in the fall if one has access to a greenhouse.

The second part deals with the spore plants, beginning with the blue-green algae and ending with the angiosperms. The more important structures are considered and emphasis is laid on the relationship and classification of the various groups. This work can be given either in the fall or spring but to the mind of the reviewer it would appropriately follow work in the spring.

Finally the book closes with thirty-six experiments in phsyiology. These can be scattered through the general work, given successively or used for general demonstrations as the teacher may desire.

The course thus outlined is practicable and workable and fitted to the mental capacity of the average high school student and will give a substantial botanical training both for practical life and as a stepping stone to further botanical studies.

John H. Schaffner.

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TABLE OF CONTENTS.

A LIST OF THE LICHENS OF OHIO.

J. C. HAMBLETON.

The following list of lichens is made up principally from the collection in the State Herbarium at the Ohio State University. It, of course, is not complete. No serious collecting has been done for many years, and undoubtedly a large number will yet be found. This list has been approved by Prof. A. Zahlbruchner, of Vienna, and is in accord with his classification in the Engler-Prantl Pflanzenfamilien.

Verrucariaceae.

Verrucaria rupestris Schrad.
V. muralis Ach.
V. nigrescens Pers.

Dermatocarpaceae.

Dermatocarpon miniatum (L.) Mann.
Endocarpon miniatum (L.) Schaer).
D. aquaticum (Weiss.) A. Zahlbr.
(*Endocarpon miniatum, aquaticum Schaer.*)
D. pusillum (Ach.) A. Zahlbr.
(*Endocarpon pusillum Hedw.*)

Pyrenulaceae.

Lepthoraphis epidermidis (Ach.) Th. Fr.
(*Sagedia oxyspora (Nyl.) Tuck.*)
Pyrenula nitida (Weig.) Ach.
P. glabrata (Ach.) Mass.
P. gemmata (Ach.) Naeg.

Trypetheliaceae.

Trypethelium virens Tuck.

Caliciaceae.

Chaenotheca chrysocephala (Turn) Th. Fr.
(*Calicium chrysocephalum (Turn.) Ach.*)
Stenocybe byssaca (Fr.) Nyl.
(*Calicium byssaceum Fr.*)

Cypheliaceae.

Cyphelium tigillare (Pers.) Th. Fr.
(*Acolium tigillare (Ach.) DeNot*)

Arthoniaceae.

Arthonia dispersa (Schrad.) Nyl.
A. radiata (Pers.) Th. Fr.
(*Arthonia astroidea Ach.*)
A. punctiformis Ach.
A. pyrhuliza Nyl.
A. lecideella Nyl.
A. polymorpha Tuck.
Arthothelium spectabile (Fl.) Mass.
(*Arthonia spectabile Fl.*)

Graphidaceae.

Opegrapha varia Pers.
O. vulgata Ach.
Graphis scripta (L.) Ach.

Lecanactidaceae.

Lecanactis premnea, chlorocomia Tuck.

Lecidiaceae.

Lecidia coerulescens (Wulf.) Schaer.
L. russula Ach.
(*Biatora russula (Ach.) Mont.*)
L. russellii Tuck.
(*Biatora russellii Tuck.*)
L. cinnabarina Smf.
(*Biatora cinnabarina (Fr.)*)
L. varians Ach.
(*Biatora varians Ach.*)
Bacidia rubella (Ehrh.) Mass.
(*Biatora rubella Rabenh.*)
B. fuscorubella (Hoffm.) Arn.
(*Biatora fuscorubella Tuck.*)
B. suffusa (Fr.) A. Zahlbr.
(*Biatora suffusa Fr.*)
B. schweinitzii (Fr.) A. Zahlbr.
(*Biatora schweinitzii Fr.*)
B. chlorantha (Tuck.) A. Zahlbr.
(*Biatora chlorantha Tuck.*)
Toninia granosa (Tuck.) A. Zahlbr.
(*Lecidea granosa Tuck.*)
Lopadium leucoxanthum (Sprgl.) A. Zahlbr.
(*Heterothecium leucoxanthum Mass.*)
Rhizocarpon petraeum (Nyl.) A. Zahlbr.
(*Buellia petraea (Flot. Koerb.) Tuck.*)
R. applanatum (Fr.) Th. Fr.
(*Lecidea colludens Nyl.*)

Cladoniaceae.

Cladonia cariosa (Ach.) Spreng.
C. caespiticia Pers.
C. coccifera (L.) Willd.
(*Cladonia cornucopioides (L.) Fr.*)
C. cornuta (L.) Schaer.
C. cristatella Tuck.
C. degenerans Floerk.
C. delicata (Ehrh.) Floerk.
C. fimbriata (L.) E. Fr.
C. fimbriata, adspersa Tuck.
C. fimbriata, simplex (Weis.) Fl.
(*C. fimbriata, tubaeformis Fr.*)
C. furcata Huds.) Schrad.
C. furcata, racemosa (Hoffm.) Floerk.
C. furcata, subulata (Ach.) Floerk.
C. crispata (Ach.) Fw.
(*C. furcata, crispata Floerk.*)
C. gracilis (L.) Willd.
C. gracilis, hybrida Schaer.
C. verticillata Hoffm.
(*C. gracilis verticillata Fr.*)
C. macilenta (Hoffm.) Nyl.
C. mitrula Tuck.
C. papillaria, molariformis Hoffm.
C. pyxidata (L.) E. Fr.
C. rangiferina (L.) Hoffm.
C. alpestris (L.) Rabh.
(*C. rangiferina, alpestris L.*)
C. sylvatica (L.) Hoffm.
(*C. rangiferina, sylvatica L.*)
C. squamosa (Scop.) Hoffm.
C. squamosa, ventricosa, Fr.
C. symphicarpa, epiphylla (Ach.) Nyl.
C. uncialis (L.) Web.

Gyrophoraceae.

Gyrophora dillenii (Tuck.) Mull.
(*Umbilicaria Dillenii Tuck.*)
Umbilicaria pustulata (L.) Hoffm.

Acarosporaceae.

Biatorella simplex (Dav.) Th. Fr.
(*Lecanora privigna (Ach.) Nyl.*)
Acarospora squamulosa (Schrad.) Th. Fr.
(*Lecanora cervina (Pers.) Nyl.*)

Collemaceae.

Collema pycnocarpum Nyl.
C. cyrtaspis Tuck.
C. nigrescens (Leers) Wainio.
C. ryssoleum Tuck.
C. tenax (Sw.) Ach.
C. crispum Borr.
C. flaccidum Ach.
Leptogium lacerum (Sw.) S. Gray.
L. tremelloides (L. fil.) Wainio.
L. pulchellum (Ach.) Nyl.
L. chloromelum (Sw.) Nyl.
L. hildebrandii (Garvogl.) Nyl.
(*L. myochroum, saturninum Schaer.*)
L. saturninum (Dicks.) Nyl.
(*L. myochroum (Ehrh.) Tuck.*)

Heppiaceae.

Heppia virescens (Despr.) Nyl.
(*Heppia despreauxii (Montag.) Nyl.*)

Pannariaceae.

Pannaria rubiginosa (Thunb.) Del.
P. leucosticta Tuck.

Stictaceae.

Lobaria amplissima (Scop.) Arn.
(*Sticta amplissima (Scop.) Mass.*)
L. quercizans Michx.
(*Sticta quercizans (Michx.) Ach*)
L. pulmonaria (L.) Hoffm.
(*Sticta pulmonaria (L.) Ach.*)
Sticta aurata Ach.

Peltigeraceae.

Nephromium helveticum (Ach.) Nyl.
Peltigera aphthosa (L.) Hoffm.
P. horizontalis (L.) Hoffm.
P. canina (L.) Hoffm.
P. spuria (Ach.) DC.
  (*P. canina, spuria Ach.*)
P. rufescens (Sm.) Hoffm.
P. scutata (Dicks.) Leight.

Pertusariaceae.

Pertusaria velata (Turn.) Nyl.
P. multipuncta (Turn.) Nyl.
P. communis DC.
P. leioplaca (Ach.) Schaer.

Lecanoraceae.

Lecanora subfusca (L.) Ach.
L. miculata Ach.
L. pallida (Schreb.) Schaer.
L. hageni Ach.
L. varia Ach.
Ocrolechia tartarea (L.) Mass.
  (*Lecanora tartarea (L.) Ach.*)
O. pallescens (L.) Mass.
  (*Lecanora pallescens (L.) Schaer.*)
O. pallescens, rosella (Tuck.)

Parmeliaceae.

Candelaria concolor (Dicks.) Wainio.
  (*Theloschistes chrysophthalamus (L.) Th. Fr.*)
Parmelia pertusa (Schrank.) Schaer.
P. furfuracea (L.) Ach.
  (*Evernia furfuracea (L.) Mann.*)
P. olivacea (L.) Nyl.
P. tiliacae (Hoffm.) Ach.
P. rudecta Ach.
  (*Parmelia borreri, rudecta Tuck.*)
P. saxatilis (L.) Ach.
P. cetrata Ach.
P. cylisphora (Ach.) Wainio.
  (*Parmelia caperata (L.) Ach.*)
P. perforata (Wulf.) Ach.
P. perlata Ach.
P. crinita Ach.
Anzia colpodes (Michx.) Stizbg.
  (*Parmelia colpodes (Ach.) Nyl.*)
Cetraria aleurites (Ach.) Th. Fr.
C. aurescens Tuck.
Nephromopsis ciliaris (Ach.) Hue.
  (*Cetraria ciliaris Ach.*)

Usneaceae.

Ramalina calicaris (L.) E. Fr.
R. calicaris, canaliculata Fr.
R. fraxinea Ach.
R. populina (Ehrh.) Wainio.
  (*Ramalina fastigiata Ach.*)
R. pollinaria Ach.
Usnea florida (L.) Hoffm.
  (*U. barbata, florida Fr.*)
  (*U. barbata, florida, hirta, Fr.*)
  (*U. barbata, florida, rubiginea Michx.*)
U. angulata Ach.
U. ceratina Ach.
  (*U. barbata (L.) Fr.*)

Caloplacaceae.

Blastenia ferruginea (Huds.) Arn.
  (*Placodium ferrugineum (Huds.) Hepp.*)
B. camptidia (Tuck.) A. Zahlbr.
  (*Placodium camptidium Tuck.*)
Caloplaca aurantiaca (Lightf.) Th. Fr.
  (*Placodium aurantiacum (Lightf.) Naeg. & Hepp.*)
C. cerina (Ehrh.) A. Zahlbr.
  (*Placodium cerinum (Hedw.) Naeg. & Hepp.*)
C. cinnabarina (Ach.) A. Zahlbr.
  (*Placodium cinnabarinum (Ach.) Anz.*)

Theloschistaceae.

Xanthoria parietina (L.) Th. Fr.
  (*Theloschistes parietinus (L.) Norm.*)
X. polycarpa Th. Fr
  (*Theloschistes polycarpus Ehrh.*)

Buelliaceae.

Buellia parasema (Ach.) Th. Fr.
B. myriocarpa (DC.) Mudd.
Rinodina atrocinerea (Dicks.) Korb.
  (*Rinodina sophodes, atrocinerea Nyl.*)

Physciaceae.

Pyxine sorediata Fr.
Physcia stellaris (L.) Nyl.
P. obscura (Ehrh.) Th. Fr.
P. pulverulenta (Hoffm.) Nyl.
P. adglutinata (Flk.) Nyl.
P. astroidea (Fr.) Nyl.
P. leana Tuck.
P. tribacea (Ach.) Nyl.
Anaptychia hypoleuca (Muhl.) Wainio.
  (*Physcia speciosa, hypoleuca (Muhl.) Tuck.*)
A. speciosa (Wulf.) Wainio.
  (*Physcia speciosa (Wulf.) Nyl.*)
A. comosa (Eschw.) Trevis.
  (*Physcia comosa (Schw.) Nyl.*)
A. leucomela (L.)
  (*Physcia leucomela (L.) Michx.*)

MONOCHYTRIUM, A NEW GENUS OF THE CHYTRIDIALES, ITS LIFE HISTORY AND CYTOLOGY.*

ROBERT F. GRIGGS.

In working over sections of leaves and stems of the common Ragweed, Ambrosia artemisifolia, infested with Rhodochytrium spilanthis the cytology of which had interested the writer in connection with his work on Synchytrium, he found that there was present along with the Rhodochytrium another parasite. It was at first supposed that the new plant was an early stage of Rhodochytrium but it was soon found that it had nothing in common with Rhodochytrium except its host plant, being distinct in all of the details of its cytology as well as in its method of parasitism and its life history. Whereas Rhodochytrium is an intercellular parasite infesting the fibrovascular bundles of its host into which it sends numerous haustoria to gather its nutrition, the new plant which I shall term *Monochytrium* leads an intracellular existence within the epidermal, hypodermal or more rarely the chlorenchyma cells of its host thus resembling in its mode of life such species of Synchytrium as S. taraxici, a resemblance which is further increased by the absence of haustoria. From these plants, however, Monochytrium differs markedly in the binucleate sexual resting spores and in the solitary zoosporangia in allusion to which the generic name has been chosen.

After Monochytrium was discovered a considerable amount of the Ragweed infested with Rhodochytrium was examined in the hope of detecting the new parasite in the living state and of observing its grosser characters and its zoospores. This search was, however, fruitless, which is not surprising in view of the habits of the fungus. For while the parasite is extraordinarily abundant in certain small areas of the sections (Fig. 1), such areas are seldom found. Out of 200 slides Monochytrium was observed in only 10. Furthermore, the parasite deforms its host only very slightly so that infested areas would not be easy to find unless they were abundant. The Rhodochytrium material from which the slides were made was supplied me by the kindness of my good friend, Professor F. L. Stevens, and his colleague, Mr. J. G. Hall of the North Carolina Agricultural Experiment Station. It was collected at Raleigh on July 3, 11, and 18, 1908, and was a portion of the material sent by Dr. Stevens to Professor Atkinson from which he published his two notes on Rhodochytrium. It was killed in Chromacetic acid, imbedded in paraffine

*Contributions from the Botanical Laboratory of the Ohio State University No. 51.

in the usual way, sectioned 5-10μ thick, and stained on the slide with Heidenhein's Iron Alum Haematoxylon and with Analin Safranin and Gentian Violet. Either stain is satisfactory but most of the drawings have been made from material stained with the Safranin-Violet combination.

The youngest stages of the parasite found were imbedded in the cytoplasm of the host cell (Fig. 2). They were minute amoeboid cells whose size (3μ) corresponds rather closely with that of the segments of the zoosporangium. Not infrequently the perforations by which the young parasite had entered the host cell may be seen in section as thickenings on the inside of the wall of the host (Figs. 8, 10). In rare instances slight thickenings may also be observed on the outside surface of the wall (Fig. 13). In other cells cut tangentially so as to allow one to look through the perforations (Fig. 3) one sees that the holes are surrounded by irregular cellulose thickenings. In appearance these collars resemble somewhat the irregular growths of bark around a healing wound on a tree trunk and suggest that they were secreted by the cytoplasm of the host cell in an attempt to repair the damage; in many instances there are indications that such repair is completed for in most of the infected cells the points of entrance appear to be simply thickened places on the walls and no perforation can be observed by focusing up and down.

In favorable locations the young amoebulae imbedded in the host cytoplasm are extremely abundant, hardly a cell being free from parasites (Fig. 1). Moreover, there are frequently nearly a dozen in a single cell (Fig. 2). Their minute size precludes very exact observations as to their structure but as compared with the segments of the zoosporangia from which they are supposed to have come their cytoplasm is less dense, containing, apparently almost from the beginning, several relatively large vacuoles (Fig. 5), between the meshes of the reticulate cytoplasm. Of the nucleus little can be seen beyond the deeply staining nucleolus and the nuclear membrane, though by analogy with the larger nuclei of later stages it may be supposed to have more or less of a chromatin reticulum in addition. Lying in the cytoplasm close beside the nucleus there is frequently a deeply staining body (Figs. 5, 6) whose general appearance at once suggests a centrosome. No such structure was observed at any other stage of the life history but it is not impossible that one may be associated with the flagella of the zoospores. But as long as the zoospores themselves remain unknown it is idle to speculate on the matter. The deeply staining bodies in question occur, however, with sufficient frequency to make it very desirable to be able to offer some interpretation of their presence.

In almost every cell in which there are several of these amoebulae they may be seen to become associated in pairs, (Fig. 4), coming into closer and closer contact until the plasma membrane between them breaks down and the cytoplasm of the two fuses (Figs. 5, 6). All stages in this conjugation except the disappearance of the plasma membrane are very easy to observe, many dozen of them being found in my slides. The nuclei, however, do not fuse though they may in the early stages lie close together. Immediately after conjugation which seems to take place soon after the amoebulae have entered their host, growth begins and seems to proceed rather rapidly judging from the fact that conjugating forms are much more abundant than such stages as are shown in Figs. 8 and 9, which immediately follow. Without any further change in structure the zygote continues to grow until it has completed its active life when it encysts and becomes a binucleate resting spore.

Though there are frequently two or even more than two zygotes in a single cell all of the amoebulae do not succeed in conjugating. Such as fail become large coenocytes which ultimately segment into zoosporangia. The very early stages in the division of the nuclei of these zoosporangia are so minute and difficult to follow that one can hardly be certain of the correctness of his conclusions. But apparently the nucleus fragments by constriction into about four daughter nuclei while the parasite is yet very small (Fig. 13, a). These do not further subdivide until a considerable enlargement both in nuclei and cytoplasm of the parasite has taken place. (Fig. 13, b). Such quadrinucleate parasites are fairly abundant and from this stage on the course of development is easy to follow. The parasite increases from 10–15μ, usually to about 70μ and the nuclei multiply until they become exceedingly numerous and very minute (Figs. 14–17). No spindles were observed at any time in this process of multiplication, while some clear cases of amitosis were seen (Fig. 14). The nuclei are so minute however, that it cannot be stated positively that amitosis is the sole method of nuclear division. At the end of this vegetative period the cyst segments into a zoosporangium (Fig. 18), with an immense number of spores so minute (2.5μ) that their finer structure cannot be made out.

In the intermediate stages of the active cycle both of the resting spores and the zoosporangia there is a strong tendency for the vacuoles of the cytoplasm to coalesce to form one large central vacuole (Figs. 14–17), traversed only by very fine strands of cytoplasm. This central vacuole may appear very early (Fig. 14) or it may not appear at all (Figs. 9–13). During these stages also refringement deeply staining granules frequently appear on the strands of cytoplasm (Figs. 11, 16). These resemble closely the

similar granules found in the cytoplasm of many species of Synchytrium.

Resting spores and zoosporangia are likewise entirely similar in their relations to the host cell. As already indicated the parasites in their first stages lie imbedded in the cytoplasm of the host cell. As they grow older they continue to be surrounded by a more or less definite layer of host cytoplasm but soon establish definite relations with the host nucleus also which becomes so appressed against the parasite as to be markedly deformed (Figs. 8, 11, 15). There is no indication, however, that the immediate injury to the nucleus is very great. Though death is the ultimate result to the host cell the relations of parasite and host appear to be to a certain extent mutualistic. The host nucleus maintains its finer structure and staining reaction unchanged to the end and gives no indication of such abnormal behavior as Von Gutenberg, Kusano and others have reported in the nuclei of the host cells surrounding the galls of Synchytrium. The presence of the parasite causes some hypertrophy of the host cell which gradually enlarges to dimensions considerably in excess of its original size (Cf. Figs. 8, 13, with Figs. 12, 18). The enlargement is however very seldom sufficiently great to cause galls such as occur in Synchytrium. For the most part the hypertrophied cells find room not by swelling out from the surface of the host but by pushing aside the adjacent cells (Figs. 1, 16). These compressed cells are however, only slightly injured considering the degree to which they are distorted (cf. Fig. 2 which shows a cell lying adjacent to a large zoosporangium and distorted by it.) There is surprisingly little of the disorganization of the tissues which is usually met with in such cases but the nuclei and chloroplasts of the affected cells retain their characteristic form and staining reaction even when the cell walls are so crowded that the outlines of the individual cells are no longer discernible as in cases like Fig. 16.

The size which is attained before the active life is completed and encystment takes place varies from 30 to 50μ depending probably on the amount of nutriment available for the parasite. When it first appears (Fig. 11) the wall of the resting spore is a thin transparent membrane secreted around the periphery of the parasite. When older it becomes a thick yellow wall (Fig. 12) which is homogeneous, one layered and smooth on the outer surface except for irregular roughenings due apparently to the adherent debris from the contents of the host cell. The spore wall is certainly not composed of cellulose; at no stage in its formation does it take the stain as do the walls of the host or the three layered cellulose walls of the resting spores of Rhodochytrium which are found together with it in the same slides. Its

general appearance is identical with that of the resting spores of Synchytrium which Von Gutenberg has recently determined to be chitinous. On account of the scarcity of material, however, michrochemical tests to determine its composition were not undertaken.

General Considerations.

The relationships of Monochytrium are in the present state of our knowledge regarding the Chytrids somewhat obscure. Its method of parasitism and general structure are similar to those of Synchytrium and, had the present plant been described without reference to its cytology, the only difference between the two genera that would have been noticed is the difference in segmentation which in Synchyrium results in the formation of zoosporangia each of which in turn gives rise to numerous zoospores while in Monochytrium the zoospores are formed directly, each cyst becoming a single zoosporangium. This difference is however of itself sufficient to remove the plant from the Synchytriaceae and place it among the Olpidiaceae. From all the genera of this family Monochytrium may be separated at once by its habitat. All the other genera are parasites of aquatic plants or animals except Asterocystis which infests the roots of the seed plants.

So far as the writer is aware in no other plant has a conjugation of gametes been reported to occur after the young parasites have infected their host. But when the cytology of the lower organisms especially of their early stages is better known it may be found that such a conjugation is not so rare as now appears. It is quite possible that many forms now supposed to be nonsexual may conjugate after infecting their host. The life history of most species of Synchytrium for example would seem to demand some difference in constitution between the summer sori and the resting spores similar to this belated conjugation of Monochytrium; but if such a sexual act exists it is obvious that in these cases the nuclei also must fuse. The continued independence of the nuclei of the zygote may be more unusual but when it is recalled in how few of the zygospores of the lower plants are the actual conditions of the nuclei known, it is evident that such a plasma conjugation may be more common than now suspected. This long continuance of the apylogamic phase in Monochytrium cannot fail to recall the similar phenomena in the nuclei of the higher fungi. Nothing could be of greater interest than to determine the fate of these two nuclei in the germination of the resting spore. Attempts at germination must however wait upon more abundant material than is now available.

It is hoped that an opportunity may also be presented to observe the zoospores in the living condition in order to deter-

mine their behavior and their structure, particularly the characters of their organs of locomotion. For it will be recalled that while in many groups the number and position of the flagella are so constant as to be made the basis of distinctions of ordinal or of even higher rank, in the Chytridiales they are very variable for one finds in genera undoubtedly closely related great diversity in this regard. The zoospores of Synchytrium for example have one flagellum while those of Woroninella have two. The behavior of the zoospores of some of the Chytrids goes to show that the flagella of this group may be of very indefinite organization. Atkinson has shown that when liberated inside the sporangium the zoospores swim actively forward until they strike the wall of the sporangium when the flagella are retracted and the zoospore puts out pseudopodia by which it gropes for the opening of the sporangium. In case it is located too far from the ostiole to reach it with its pseudopodia it resumes its flagellate form and swims about again until it finally escapes. Such behavior indicates very plainly that the flagella of these zoospores resemble the long actively lashing pseudopodia present in such of the Protozoa as Mastigamoeba more than the definite highly specialized motile organs of the Protococcoid forms. In the latter group the zoospores have no power of retracting and again putting forth their flagella but retain the same ones throughout their active stage. Comparisons of flagella based on analogies to the highly specialized organs of other groups must obviously be of somewhat doubtful value.

Indications are not lacking that the spores of Monochytrium are even more widely different from the typical flagellate zoospore than those of other Chytrids. For it seems probable from the habits of the fungus that the motile organs of Monochytrium spores are very inefficient as compared with those of the Synchytria. In each area where it has been found the abundance of the individual parasites was very great. At the same time the infested areas are narrowly circumscribed. This is in strong contrast to the habit of Synchytrium which is always widely distributed over the plant and seldom so excessively abundant as Monochytrium. This is especially evident when one considers the young stages of the parasite. Such a complete series of young stages as here figured for Monochytrium would be exceedingly difficult to assemble for any species of Synchytrium with which I am familiar; in very much more extensive work with Synchytrium decipiens in all stages the writer has never seen so much as one percent of the young stages that he has in Monochytrium. The reason is that the parasites are so much more widely scattered that their detection when very small is difficult. Nevertheless,

Monochytrium presumably has as great an opportunity for the dispersal of its spores in dewdrops and spattering rain as has Synchytrium. The writer is therefore led to expect that when the zoospores of Monochytrium are observed they will be found to be amoeboid rather than flagellate.

For a summary of the most important points in the life history of Monochytrium a condensed technical description may be offered. The type and only known species I propose to name in honor of Professor F. L. Stevens who has made notable contributions to the cytology of the lower fungi.

Monochytrium gen. nov.

Mycelium nullum, plasmodium rotundatum; sporae perdurantes 30-50μ, globosae, ortae a copulationis zoosporarum intra cellulas matricis, binucleatae, exosporio crasso, paene levi non echinulata; zoosporangia circa 70μ, formata a zoosporis sine copulatione, unum a quoque plasmodio, sine membrana, sine collo; zoosporae numerosissimae, 2.5μ, moto ignoto.
Intra cellulas epidermicas aut hypodermicas aut raro chlorenchymatas plantarum viventium.

Monochytrium stevensianum sp. nov.

Characteribus generis. Intra cellulas foliarum petiolorumque Ambrosiae artemisiifoliae in Raleigh, Carolina boreali; Stevens & Hall Julio 1908.

The slides containing the type specimens are deposited in the herbarium of the Ohio State University. With them are index cards giving the location of the cysts drawn, in vernier readings of the Spencer Lens Company's mechanical stage No. 490 with the verniers set to read 30 and 90 respectively when the aperture in the centering slide accompanying the instrument occupies the optical axis of the microscope. The originals of all the figures may therefore be quickly found with any microscope equipped with a No. 490 mechanical stage, or with any mechanical stage with a vernier reading to tenths of millimeters for after one is found and the differences in reading between stage No. 490 and the one employed are determined, all may be located by simple additions to the readings given.

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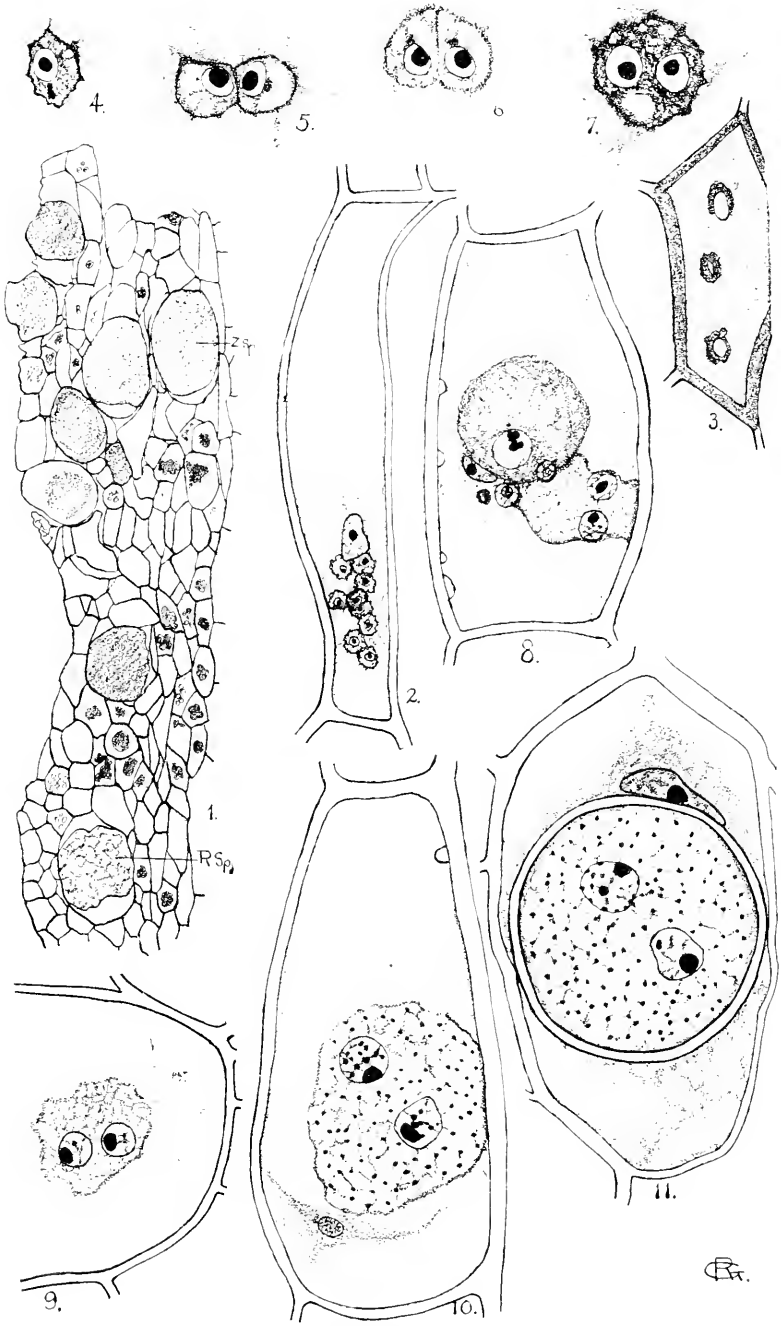
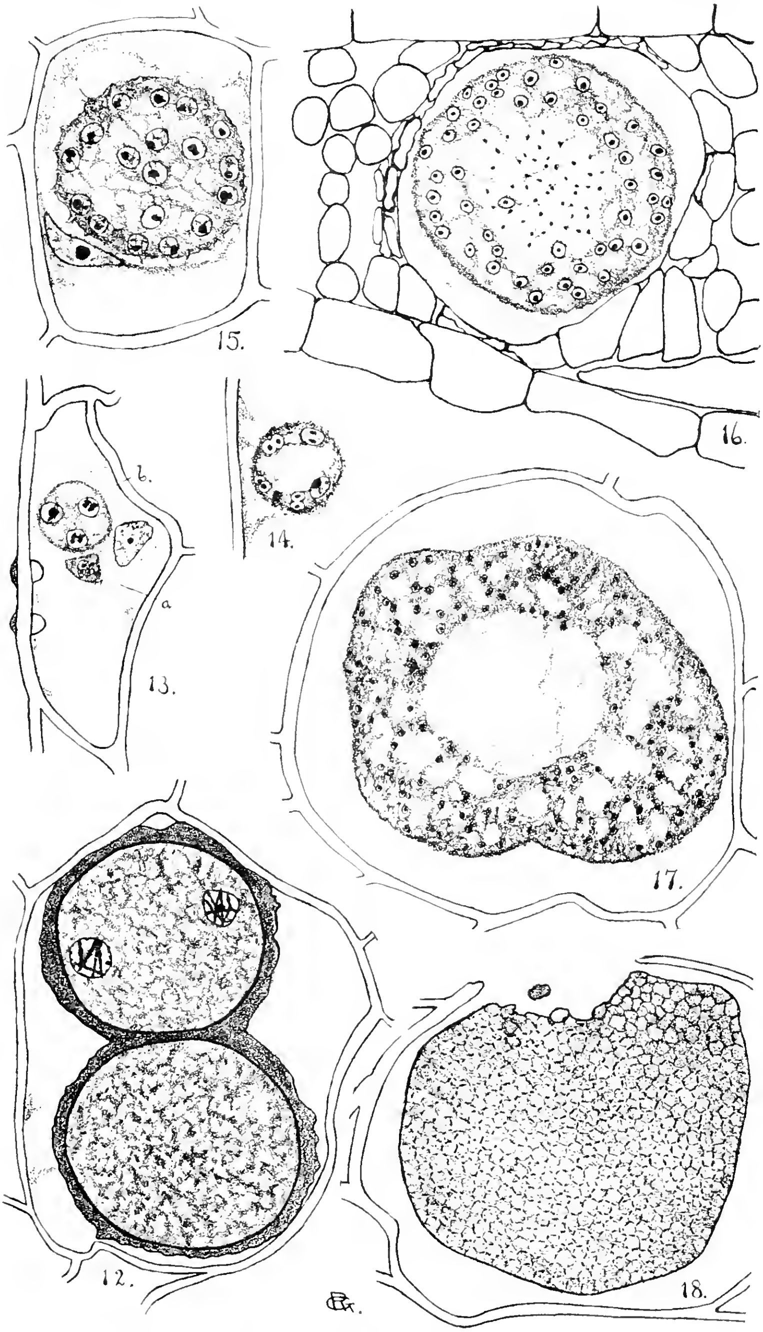


GRIGGS on "Monochytrium."



GRIGGS on "Monochytrium."

EXPLANATION OF PLATES III AND IV.

All figures are camera drawings from sections. All except Figs. 1, 3–7, were made with a Spencer 1.5 mm. immersion objective and compensating ocular 4 giving a magnification of approximately 670 diameters. Fig. 1 was drawn with an 8 mm. objective and 4 ocular giving an approximate magnification of 125 diameters; Fig. 3 with the 1.5 mm. objective and 3 ocular, magnification 533; Figs. 4–7 with objective 1.5 and ocular 12, magnification 2130. The plates were reduced to 2-3 of their original size exactly eliminating the enlargement due to the camera and rendering them the same size as seen in the microscope.

PLATE III.

Fig. 1. A tangential section through the hypodermis of the wing of the petiole of the Ragweed, showing the general relations of the parasites to the tissue of the host. R. Sp. Resting Spores, Z. Sp. Zoosporangia.

Fig. 2. A cell with numerous amoebid zoospores imbedded in the host cytoplasm; one pair of zoospores conjugating; cell distorted by an adjacent zoosporangium measuring $45 \times 60\ \mu$, note slight degree of injury.

Fig. 3. A tangential section of a host cell wall showing perforations where the parasites entered.

Fig. 4. One of the zoospores from Fig. 2.

Fig. 5. Zoospores just beginning to conjugate.

Fig. 6. Conjugating zoospores.

Fig. 7. Conjugation complete.

Fig. 8. A cell with two young zygotes, each binucleate, and several unconjugated zoospores; note cellulose plugs marking the points where the parasites entered.

Fig. 9. A young zygote.

Fig. 10. Zygote nearly full grown.

Fig. 11. A young resting spore; note slight injury to the nucleus and cytoplasm of the host cell.

Fig. 12. Two ripe resting spores within same host cell; each binucleate though the nuclei of the lower spore do not lie within the plane of section.

Fig. 13. A cell with two young parasites; *a* probably the first division (amitotic) of the zoospore; *b*, a plasmodium with four nuclei; on the wall are shown the plugs marking the points of entrance.

Fig. 14. A young plasmodium with eight nuclei most of which are in process of amitosis; central vacuole developed unusually early.

Fig. 15. A plasmodium with about 60 nuclei; central vacuole beginning to appear; note relations of parasite and host nucleus.

Fig. 16. A larger plasmodium with well developed central vacuole lying in the chlorenchyma of its host; note slight injury beyond mechanical distortion.

Fig. 17. A full sized plasmodium with very many nuclei.

Fig. 18. A ripe zoosporangium; opening at top may be natural or due to knife.

MEDICINAL PLANTS OF OHIO.

FREDA DETMERS.

This list includes the uncultivated and a few of the common cultivated medicinal plants of Ohio. It is compiled from the United States Pharmacopoeia, King's American Dispensatory for the Eclectic School of Medicine and the American Homeopathic Dispensatory. The individual citation follows the name of each plant. When the technical name given in the Dispensatory or Pharmacopoeia differs from that in Britton's Manual it is given as a synonym. The technical and popular name and the part used as a drug are given for each plant.

FUNGI.

Ascomycetae.

Hypocreaceae.

Claviceps purpurea (Fr.) Tul. Ergot. (U. S. P.) (Ec.) *Sclerotium.*

Teleosporeae.

Ustilaginaceae.

Ustilago maydis Lev. Corn Smut. (Ec.) (Hom.). *Fungus.*

Basidiomycetae.

Polyporaceae.

Fomes fomentarius Fr. (*Polyporus fomentarius* Fr.) Bracket fungus. (Ec.) *Fungus.*

Fomes igniarius Fr. (*Polyporus igniarius* Fr.) (Ec.) *Fungus.*

Fomes pinicola (Sw.) Fr. (*Polyporus pinicola* (Sov.) Fr.) (Ec.) (Hom.) *Fungus.*

Agaricaceae.

Amanita muscaria L. Fly Agaric. (Ec.) *Fungus.*

Amanita phalloides Fr. Deadly Amanita, Death cup. (Ec.)

Lycoperdaceae.

Calvatia gigantia Batsch. (*Lycoperdon bovista*). Giant Puffball. (Ec.) *Spores.*

Lichenes.

Sticta pulmonaria L. Lungwort Lichen. (Ec.) (Hom.) *Plant.*

BRYOPHYTA.

Musci.

Polytrichaceae.

Polytrichum juniperum Willd. Hair-cap Moss. (Ec.) (Hom.) *Plant.*

Pteridophyta Homosporeae.

Filices.

Polypodiaceae.

Polypodium vulgare L. Polypody. (Ec.) Hom.) *Rhizome and leaves.*
Adiantum pedatum L. Maiden-hair Fern. (Ec.) (Hom.) *Plant.*
Pteridium aquilinum Kuhn. (*Pteris aquilina* L.) Brake. (Ec.) *Plant.*
Asplenium trichomanes L. Spleenwort. (Ec.) *Plant.*
Asplenium ruta-muraria L. White maiden-hair. (Ec.) *Plant.*
Asplenium filix-foemina (L.) Bernh. Lady-Fern. (Ec.) *Rhizome.*
Dryopteris marginalis (L.) A. Gr. Marginal Shield-fern. (Ec.) *Rhizome.*
Dryopteris filix-mas (L.) Schott. Male Fern. (U. S. P.) (Ec.) *Rhizome.*

Osmundaceae.

Osmunda regalis L. Royal Flowering-fern. (Ec.) *Rhizome.*
Osmunda cinnamomea L. Cinnamon-fern. (Ec.) *Rhizome.*

Equisetaceae.

Equisetum arvense L. Field Horse-tail. (Ec.) (Hom.) *Plant.*
Equisetum laevigatum A. Br. Smooth Scouring Rush. (Ec.) *Plant.*
Equisetum hyemale L. Scouring Rush. (Ec.) (Hom.) *Plant.*
Equisetum robustum A. Br. (Ec.) *Plant.*

Lycopodiaceae.

Lycopodium clavatum L. and other species of Club Moss. (U. S. P.) (Ec.) (Hom.) *Spores.*

GYMNOSPERMAE.

Coniferae.

Pinaceae.

Pinus sylvestris L. Scotch Pine. (U. S. P.) (Hom.) *Leaves and young twigs. Distillation of wood.*
Larix laricina (Du Roi) Koch. (*L. americana* Mx.) American Larch. (Ec.) (Hom.) *Bark.*
Picea excelsa (L.) Karst. (*Abies excelsa* Karst.) Norway Spruce cult. (Hom.) *Leaves and young twigs.*
Tsuga canadensis (L.) Carr. (*Abies canadensis* Mx.) Hemlock. (Ec.) (Hom.) *Sap.*
Thuja occidentalis L. Arbor Vitae. (Ec.) (Hom.) *Twigs and leaves.*
Juniperus communis L. Common Juniper. (Ec.) (Hom.) *Fruit.*
Juniperus virginiana L. Red Cedar. (Hom.) (Ec.) *Leaves and twigs.*

ANGIOSPERMAE.

Monocotylae.

Typhaceae.

Typha latifolia L. Cat tail. (Ec.) *Root.*

Gramineae.

Zea mays L. Indian corn cult. (U. S. P.) (Ec.) *Silk. Starch grains.*
Triticum sativum Lam. Wheat cult. (Ec.) *Flour.*
Sorghum vulgare. Broom corn cult. (Ec.) *Seed.*
Avena sativa L. Oat cult. (Ec.) *Seed.*
Agropyron repens L. (*Triticum repens* L.) Couch or Quick Grass. (U. S. P.) (Ec.) (Hom.) *Rhizome gathered in the spring.*
Hordeum distichon L. Barley cult. (U. S. P.) (Ec.) *Malt.*

Cyperaceae.

Carex arenaria L. German Sarsaparilla, Sand Sedge. (Ec.) *Plant.*

Araceae.

Arisaema triphyllum Torr. Indian Turnip, Jack-in-the-pulpit. (Ec.) *Corm.*
Spathyema foetida (L.) Raf. (*Symplocarpus foetidus* Salisb.) Skunk Cabbage. (Ec.) (Hom.) *Rhizome, roots and seed.*
Acorus calamus L. Sweet Flag. (U. S. P.) (Ec.) (Hom.) *Rhizome.*

Liliaceae.

Chamaelirium luteum Gr. (*Helonias lutea* Ait.) Blazing Star. (Ec.) *Rhizome.*
Veratrum viride Soland. American Hellebore. (U. S. P.) (Ec.) (Hom.) *Rhizome and roots.*
Uvularia perfoliata L. Bellwort (Ec.) *Root.*
Allium cepa L. Onion cult. (Ec.) *Bulb.*
Lilium tigrinum Ker. Tiger Lily (Hom.) *Plant in flower.*
Erythronium americanum Sm. Yellow Adder's Tongue. (Ec.) *Leaves and root.*
Asparagus officinalis L. Asparagus. (Ec.) *Young shoots and roots.*
Vagnera racemosa Morong. (*Smilacina racemosa* Desf). False Solomon's Seal. (Ec.) *Rhizome and rootlets.*
Salomonia biflora (Walt.) Britt. (*Polygonatum biflorum* (Walt.) Ell.) Solomon's Seal. (Ec.) *Rhizome.*
Salomonia commutata (R. & G.) Britt. (*Polygonatum giganteum* Dietr.) Great Solomon's Seal. (Ec.) *Rhizome.*
Convallaris majalis L. Lily of the Valley. (U. S. P.) (Ec.) (Hom.) *Rhizome and roots.*
Trillium erectum L. Trillium, Wake Robin. (Ec.) (Hom.) *Root.*
Trillium sessile L. and other species. (Ec.) *Root.*
Aletris farinosa L. Colic Root. (Ec.) *Rhizome coll. in Aug.*

Dioscoreaceae.

Dioscorea villosa L. Wild Yam. Colic Root. (Ec.) (Hom.) *Root.*

Amaryllidaceae.

Narcissus pseudo-narcissus L. Daffodil cult. (Hom.) *Bulb and flowers.*

Agave virginica L. False Aloe. (Ec.) *Root.*

Iridaceae.

Iris versicolor L. Iris, Blue Flag. (U. S. P.) (Ec.) (Hom.) *Rhizome.*

Orchidaceae.

Cypripedium parviflorum Salisb. Small yellow Ladies' Slipper. (U. S. P.) (Ec.) *Rhizome and roots.*

Cypripedium candidum Muhl. White-flowered Ladies' Slipper. (Ec.) *Rhizome and roots.*

Cypripedium reginae Walt. (*C. spectabile* Swz.) Showy Ladies' Slipper. (Ec.) *Rhizome and roots.*

Cypripedium hirsutum Mill. Large Yellow Ladies' Slipper (U. S. P.) (Ec.) *Rhizome and roots.*

Cypripedium acaule Ait. Stemless Ladies' Slipper. (Ec.) *Rhizome and roots.*

Peramium pubescens (Willd.) Mac M. (*Goodyeara pubescens* R. Br.) Downy Rattle-snake Plantain. (Ec.) *Rhizome.*

Corallorhiza odontorhiza (Willd.) Nutt. Small flowered Coral-root. (Ec.) (Hom.) *Rhizome.*

Dicotylae.

Salicaceae.

Salix nigra L. Black Willow (Ec.) *Bark and aments.*

Salix alba L. White Willow. (Ec.) (Hom.). *Bark and aments.*

Populus sp. (Ec.) (Hom.) *Bark and leaf-buds.*

Myricaceae.

Comptonia peregrina (L.) Coult. (*Myrica asplenifolia* L.) Sweet Fern. (Ec.) *Leaves and tops.*

Juglandaceae.

Juglans cinera L. Butternut. (Ec.) (Hom.) *Bark of root.*

Juglans nigra L. Black Walnut. (Ec.) *Bark of root.*

Betulaceae.

Corylus americana Walt. Hazelnut. (Ec.) *Hairs from involucre.*

Ostrya virginiana (Mill.) Koch. Hop Horn beam. (Ec.) (Hom.) *Inner bark and wood.*

Carpinus caroliniana Walt. Blue Beech. (Ec.) *Bark and wood.*

Betula lenta L. Cherry Birch, Black Birch. (Ec.) *Bark and leaves.*

Alnus rugosa (Du Roy) Spreng. (Ec.) *Bark.*

Fagaceae.

Quercus alba L. White Oak. (U. S. P.) (Ec.) (Hom.) *Bark.*

Quercus rubra L. Red Oak. (Ec.) *Bark.*

Quercus velutina Lam. (*Q. tinctoria* Bart.) Black Oak. (Ec.) (Hom.) *Bark.*

Urticaceae.

Ulmus fulva Mx. Red Elm. Slippery Elm. (U. S. P.) (Ec.) *Inner bark.*
Ulmus americana L. White or American Elm. (Ec.) *Inner bark.*
Ulmus alata Mx. Winged Elm. (Ec.) *Inner bark.*
Cannabis sativa L. (C. indica.) Common Hemp. (U. S. P.) (Ec.) (Hom). *Flowering tops.*
Humulus lupulus L. Hop. (U. S. P.) (Ec.) (Hom.) *Ripe strobiles.*
Morus rubra L. Red Mulberry. (Ec.) (Hom.) *Fruit.*
Urtica dioica L. Stinging Nettle. (Ec.) (Hom.) *Leaves and root.*
Urtica urens L. Small stinging Nettle. (Hom.) *Plant.*

Aristolochiaceae.

Asarum canadense L. Wild Ginger. (Ec.) *Rhizome and roots.*
Aristolochia serpentaria L. Virginia Snakeroot. (U. S. P.) (Ec.) *Rhizome and roots.*

Polygonaceae.

Rumex brittanica L. Great Water Dock. (Ec.) *Root.*
Rumex crispus L. Yellow Dock. (Ec.) (Hom.) *Root.*
Rumex obtusifolius L. Blunt-leaved Dock (Ec.) *Root.*
Rumex acetosella L. Sheep Sorrel. (Ec.) *Leaves.*
Polygonum hydropiper L. Smart weed. (Ec.) (Hom.) *Fresh herb.*
Polygonum persicaria L. and other species of Polygonum. (Ec.) *Plant.*
Fagopyrum fagopyrum (L.) Karst. (*F. esculentum* Moench.) Buckwheat. (Ec.) *Flour from seeds.*

Chenopodiaceae.

Chenopodium ambrosioides L. Mexican Tea. (Ec.) *Fruit.*
Chenopodium anthleminticum Gr. Worm seed. (Ec.) *Fruit.*
Chenopodium album L. Pigweed. (Ec.) *Fruit.*

Phytolaccaceae.

Phytolacca decandra L. Poke Root. (U. S. P.) (Ec.) (Hom.) *Root, leaves and berries.*

Caryophyllaceae.

Alsine media L. (*Stellaria media Sm.*) Chickweed. (Ec.) (Hom.) *Plant.*
Saponaria officinalis L. Soapwort, Bouncing Bet. (Ec.) (Hom.) *Root and leaves.*

Nymphaeaceae.

Castalia odorata (Ait.) Woodv. and Wood. (Nymphaea odorata (Dryand) Ait.) White Water-Lily. (Ec.) (Hom.) *Rhizome.*
Nymphaea advena Ait. Yellow Water-Lily. (Hom.) *Rhizome.*

Ranunculaceae.

Ranunculus bulbosus L., R. acris L., R. repens L. and **R. scleratus** L. (Ec.) (Hom.) *Fresh bulbous base and flowering tops.*

Syndesmon thalictroides Hoffm. (*Anemonella thalictroides* (L.) Spach.) Rue Anemone (Ec.) *Herb.*

Hepatica hepatica (L.) Karst. (*H. triloba* Willd.) Round-lobed Liver-leaf. (Ec.) (Hom.) Leaves.

Hepatica acuta (Pursh.) Britt. (*H. acutiloba* DC.) Sharp-lobed Liver-leaf. (Ec.) *Leaves.*

Anemone virginiana L. Tall Wind-flower. (Ec.) *Plant.*

Anemone quinquefolia L. (*A. nemorosa* L.) Wood Anemone (Ec.) *Plant.*

Clematis virginiana L. Virgin's Bower (Ec.) (Hom.) *Stems, leaves and blossoms.*

Aquilegia vulgaris L. Columbine cult. (Ec.) *Herb.*

Delphinium consolida L. Field Larkspur. (Ec.) *Root, leaves, flowers and seeds.*

Delphinium ajacis L. Larkspur cult. (Ec.) *Root, leaves, flowers and seeds.*

Cimicifuga racemosa (L.) Nutt. Black Snake-root. (U. S. P.) (Ec.) (Hom.) *Rhizome and roots coll. in the autumn.*

Actaea rubra (Ait.) Willd. Red Baneberry. (Ec.) *Rhizome.*

Actaea alba Bigl. White Baneberry. (Ec.) *Rhizome.*

Hydrastis canadensis L. Golden Seal. (U. S. P.) (Ec.) (Hom.) *Rhizome and roots.*

Coptis trifolia Salisb. (*Helleborus trifolius* L.) Gold thread. (Ec.) *Rhizome.*

Magnoliaceae.

Magnolia acuminata L. Cucumber tree. (Ec.) *Bark of trunk and root with cork removed.*

Liriodendron tulipifera L. Tulip-tree . (Ec.) (Hom.) *Bark of trunk and root with cork removed.*

Anonaceae.

Asimina triloba Dunal. Papaw. (Ec.) *Seed.*

Menispermaceae.

Menispermum canadense L. Moonseed, Yellow Parilla. (Ec.) (Hom.) *Rhizome and roots.*

Berberidaceae.

Podophyllum peltatum L. May Apple. (U. S. P.) (Ec.) (Hom.) *Rhizome and roots.*

Jeffersonia diphylla Bart. Twin-leaf. (Ec.) *Rhizome.*

Caulophyllum thalictroides (L.) Mx. Blue Cohosh. (Ec.) *Rhizome and roots.*

Berberis vulgaris L. Common Barberry. (U. S. P.) (Ec.) (Hom.) *Berries, bark of rhizome and roots.*

Lauraceae.

Sassafras sassafras Karst. (*S. officinale* Nees & Ebrm.) Sassafras. (U. S. P.) (Ec.) (Hom.) *Pith and bark of root.*

Benzoin benzoin (L.) Coult. (*Lindera benzoin* Blume). Spice bush. (Ec.) *Bark and Berries.*

ADDITIONS TO THE FLORA OF CEDAR POINT. III.*

MALCOLM M. STICKNEY, JOHN H. SCHAFFNER, and CLARA A. DAVIES.

A list of the plants of Cedar Point was published by Kellerman and Jennings in June, 1904 (OHIO NATURALIST 6:186–190). This list included the species represented in the Cedar Point Herbarium belonging to the Lake Laboratory and additional names taken from Moseley's "Sandusky Flora" and other sources.

The first list of additions was published by Kellerman and York in the OHIO NATURALIST (6: 540) and a second addition was made by Jennings in the OHIO NATURALIST (6: 544–545).

During the summer of 1908 rather extensive collections were made by Professor Stickney and Miss Davies, many species proving new to the Cedar Point flora, and in the past summer further additions were made by each of the three authors of the present paper. In the interests of simplicity it was thought advisable to publish all these latter additions in a single paper. Following our list is an additional one made up from records made by Professor E. L. Moseley who kindly placed his field notes at our disposal. This list represents plants which have not been reported in any of the previous publications.

With careful collecting for one or two seasons more, our knowledge of the flora of Cedar Point should be fairly complete, and a revised general catalogue should then be published, since a local list will be of considerable value in the botanical work carried on at the Lake Laboratory.

Abutilon abutilon (L.) Rusby.
Acalypha virginica L.
Acer saccharinum L.
Agropyron tenerum Vasey.
Agrimonia mollis Britt.
Alsine media L.
Amaranthus blitoides S. Wats.
Amaranthus retroflexus L.
Andropogon scoparius Mx.
Arctium lappa L.
Asplenium filix-foemina (L.) Bernh.
Barbarea strictia Andrz.
Botrychium dissectum Spreng.
Botrychium neglectum Wood
Botrychium obliquum Muhl.
Botrychium simplex Hitch
Brassica nigra (L.) Koch.
Bromus arvensis L.
Carex rosea Schk.
Carex stricta Lam.
Cicuta bulbifera L.
Clematis virginiana L
Cuscuta gronovii Willd.
Dactylis glomerata L.
Datura tatula L.
Dryopteris Filix-mas (L.) Schott.
Echinochloa crus-galli (L.) Beauv.
Echinochloa Walteri (Pursh) Nash
Eleocharis ovata (Roth) R. & S.
Eleocharis palustris (L.) R. & S.
Eleocharis palustris glaucescens (Willd.) Gr.
Equisetum fluviatile L.
Eragrostis pilosa (L.) Beauv.
Eragrostis purshii Schrad.
Festuca elatior L.
Festuca nutans Willd
Festuca ovina L.
Galium aparine L.
Galium claytoni Mx.
Galium tinctorium L.
Holcus lanatus L.

*Presented at the meeting of the Ohio Acad. of Sci.

Hordeum jubatum L.
Ipomoea pandurata (L.) Meyer.
Juncus effusus L.
Koniga maritima (L.) R. Br.
Lactuca scariola L.
Leontodon autumnalis L.
Lespedeza capitata Mx.
Linaria linaria (L.) Karst
Lolium perenne L.
Lysimachia terrestris (L.) B. S. P.
Meibomia canescens (L.) Ktz.
Monarda mollis L.
Ophioglossum vulgatum L.
Panicularia americana (Torr.) MacM.
Panicluaria elongata (Torr.) Ktz.
Panicum capillare L.
Panicum huachucae silvicola H. & C.
Panicum pseudopubescens Nash.
Panicum villosissimum Nash.
Poa annua L.
Poa compressa L.
Poa debilis Torr.
Poa pratensis L.
Polygonum hydropiper L.
Portulaca oleracea L.
Potamogeton robbinsii Oakes.
Potentilla argentea L.
Raphanus raphanistrum L.
Ricinus communis L.
Rubus strigosus Mx.
Sagittaria rigida Pursh.
Salix discolor Muhl.
Scirpus atrovirens Muhl.
Smilax ecirrhata (Engelm.) Wats.
Smilax hispida Muhl.
Solanum carolinense L.
Symphoricarpos racemosus Mx.
Syntherisma sanguinalis (L.) DuLac.
Taraxacum taraxacum (L.) Karst.
Trifolium repens L.
Triticum vulgare L.
Veronica arvensis L.
Viola cucullata Ait
Washingtonia longistylis (Torr.) Britt.
Zanichellia palustris L.

Species catalogued as occurring on Cedar Point in Professor E. L. Moseley's unpublished records of the Flora of Sandusky.

Acnida tamariscina tuberculata (Moq.) Ul. & Bray.
Agrimonia parviflora Soland.
Allium canadense L.
Anemone cylindrica Gr.
Aster paniculatus Lam.
Atriplex hastata L.
Benzoin benzoin (L.) Coult.
Bidens aristosa (Mx.) Britt.
Bidens connata Muhl.
Bidens discoidea (T. & G.) Britt.
Bidens frondosa L.
Bidens laevis (L.) B. S. P.
Capnoides flavulum (Raf.) Ktz.
Carex pseudo-cyperus L.
Carex riparia Curtis.
Carex sparganioides Muhl.
Carex torta Boott.
Carex varia Muhl.
Cerastium arvense L.
Cerastium longipedunculatum Muhl.
Chaetochloa glauca (L.) Scrib.
Chenopodium album viride (L.) Moq.
Chenopodium botrys L.
Circaea alpina L.
Cornus circinata L'Her.
Cuscuta polygonorum Engelm
Cynoglossum officinale L.
Cyperus diandrus Torr.
Cyperus speciosus Vahl.
Cypripedium hirsutum Mill.
Epilobium coloratum Muhl.
Euphorbia maculata L.
Falcata comosa (L.) Ktz.
Geranium maculatum L.
Helianthus divaricatus L.
Helianthus tuberosus L.
Hemerocallis fulva L
Hieracium scabrum Mx.
Juglans cinerea L.
Juncus canadensis J. Gay.
Juncus nodosus L.
Lactuca spicata (Lam.) Hitch.
Liriodendron tulipifera L.
Meibomia bracteosa (Mx.) Ktz.
Meibomia dillenii (Darl.) Ktz.
Meibomia paniculata (L.) Ktz.
Myosotis virginica (L.) B. S. P.
Naias gracillima (A. Br.) Morong.
Oxalis corniculata L.
Panicum dichotomum L.
Physalis virginiana Mill.
Polygonum persicaria L.
Polygonum scandens L.
Potamogeton perfoliatus richardosnii A. Benn.

Potentilla canadensis L.
Quercus palustris Du Roi.
Rumex brittanica L.
Salix nigra Marsh.
Salomonia biflora (Walt.) Britt.
Sisyrinchium angustifolium Miller.
Sisyrinchium graminoides Bick.
Sium cicutaefolium Gmel.
Solidago nemoralis Ait.
Sorghastrum avenaceum (Mx.) Nash
Tradescantia virginiana L.
Trillium grandiflorum (Mx.) Salisb.
Triplasis purpurea (Walt.) Champ.
Viola pubescens Ait.

Errata in Lists Previously published:

Instead of Arenaria stricta Mx., read **Arenaria michauxii** (Frenzl.) Hook f.
Intsead of Geum virginicum L., read **Geum canadense** Jacq.
Instead of Hordeum pusillum Nutt., read **Hordeum jubatum** L.
Instead of Lathyrus venosus Muhl., read **Lathyrus myrtifolius** Muhl.
Instead of Panicum atlanticum Nash., read **Panicum villosisimum** Nash.
The plant in the Cedar Point herbarium labelled Rubus strigosus Mx. is **Rubus occidentalis** L.
Instead of Stipa spartina Trin., read **Stipa spartea** Trin.
Instead of Xanthium canadense Mill., read **Xanthium commune** Britt

MEETINGS OF THE BIOLOGICAL CLUB.

ORTON HALL, October 4, 1909.

The meeting was called to order by the President, Miss Detmers, and the minutes of the previous meeting were read and approved.

The Chair appointed as a committee to serve on nominations, Prof. J. H. Schaffner, Prof. C. S. Prosser, and Miss Kate Blair.

Prof. Landacre moved that the Executive Committee be instructed to ask Prof. G. W. Knight to talk, at the December meeting, upon the Darwin Centenary at Cambridge, England. Motion carried.

The program consisted of reports of summer work by the members.

Prof. J. H. Schaffner worked at the Lake Laboratory in the early part of the summer, and in conjunction with Prof. M. E. Stickney, and Miss Clara A. Davies added about eighty plants to the Cedar Point list. After returning, he did some work on leaf markings.

Prof. F. L. Landacre spoke of the work of the Lake Laboratory.

Prof. Hambleton spent part of the summer at the Lake Laboratory, and collected Hymenoptera. He also worked out the life history of Corizus lateralis.

Prof. W. C. Morse finished his work on the Waverly formations of Eastern Kentucky, and also worked on the Maxville limestone.

Prof. Griggs told of an interesting walking trip in the Hocking hills.

Miss Kate Blair spoke of a visit to the experiment station near San Diego, California, and Miss Wilson told of the tameness of the animals that she had observed in Yellowstone Park.

Prof. J. S. Hine made collecting trips in Summit County, and worked on the Tabanidae. He also did some work on the mammals of the state.

Prof. C. S. Prosser gave a very interesting account of the meeting of the British Association for the Advancement of Science, held at Winnipeg, August 25 to September 5. He spoke also of the geology of the region surrounding Winnipeg.

Orton Hall, November 1, 1909.

The Club was called to order by the President. In the absence of the Secretary, the reading of the minutes was dispensed with, and Mr. Lionel King was appointed Secretary pro tem. The following officers were nominated, and unanimously elected:

President—Mr. William C. Morse.

Vice President—Miss Emily Hollister.

Secretary and Treasurer—Malcolm G. Dickey.

The announcement was made that Prof. G. W. Knight would speak, at the December meeting, on the Darwin Centenary.

The address of the evening was given by Miss Freda Detmers, the retiring President, on "The Taxonomy and Ecology of the Plants of Cranberry Island."

Malcolm G. Dickey, *Secretary.*

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TABLE OF CONTENTS.

OHIO SPECIES OF MICE.

JAMES S. HINE.

Two different papers enumerating the Ohio species of mammals known as mice have been published. Jared P. Kirtland, in the Ohio Geological Survey Report for 1838, named four species as follows: house mouse, common white-footed mouse, jumping mouse and the meadow mouse. All of these are common in the state today, although the jumping mouse is reported as rare in some localities, but in other localities it certainly is rather plentiful. About the year 1878 A. W. Brayton of Irvington, Indiana furnished the manuscript for a report on the Mammals of Ohio, in which he listed the house mouse, white-footed mouse, rice field mouse, pine mouse, common meadow mouse, prairie meadow mouse, and jumping mouse. Two other species, namely: Cooper's mouse and the northern golden mouse were mentioned as of probable occurrence within our limits. There appears to be some mistake about the record for the prairie meadow mouse for no specimens have been reported in recent years and the material on which Brayton bases his record turns out to be the pine or mole mouse. Cooper's mouse has been taken in various parts of the state and in some places is known to be common, but no record for the golden mouse is yet reported. Of the nine species mentioned by Brayton therefore, further records of seven are at hand. Brayton's paper was published in the Report of the Ohio Geological Survey, 1882, Volume IV.

The collecting that has been done in more recent years has brought together Ohio material of at least nine species and varieties, while the work in adjoining and neighboring states suggests the possibility that four or more additional may be procured when further work has been done and all favorable localities investigated.

As time passes mammals of many kinds are more and more reduced on account of the clearing and cultivation of the land. A number of the larger species are already extirpated so far as the state is concerned and others are destined. An effort is being made at present to get together the records in regard to the species of Ohio mammals and to add species as well as records with a view to publishing an annotated list. We have a good representation of many speicies in the museum at present and it is desired to add others. I take this opportunity to state that we shall be glad to get specimens and records from any part of Ohio, especially of the larger species and such small ones as are considered of rare occurrence within our limits. The porcupine, wild cat, badger, deer and others of very uncommon occurrence may still be in the state if one happens to find them. All these have been taken in Ohio in former years, but there are a number of small animals that are suspected of inhabiting the state that have never been reported. Bats, mice and shrews are suggested as groups in which additions are most likely in our fauna.

A list of Ohio mice as at present constituted follows:

Zapus hudsonius (Zimmerman). Hudson Bay Jumping Mouse. A few specimens of this species have been taken in the state although there is some trouble in separating them from specimens of the following subspecies. Preble, in N. A. Fauna 15, reports one from Portland Station, Mahoning county and there is one in the O. S. U. museum from Ira, Summit county.

Zapus hudsonius americanus (Barton). Meadow Jumping Mouse. One belittles these interesting little animals by calling them by the mean and unrespected name of mice but the custom is so well established that it is not likely to be changed. They are easily known among Ohio mammals by their jumping or bounding mode of locomotion with which are associated very long hind legs and tail. The variety is slightly smaller and the dorsal dark area is not so distinct as in the typical species. The two are not easily told apart in the state for it seems that Ohio is largely in the section where they intergrade. In parts of the Western Reserve the meadow jumping mouse is common and one meets with specimens in various situations and under various conditions. Grass land is one of their favorite haunts but they are often seen in grain fields and in weed covered areas. It is not uncommon to start them while mowing or raking hay and in stubble ground they may be ploughed out while preparing fields for wheat. The number of young in a brood is variable no doubt but four is the number observed by myself. These quite early have nearly the color of their parents, although for some time, in fact until they are nearly full grown, the young are slightly lighter, especially is

this true of the dorsal area. Miller says that "their food appears to consist, like that of the other outdoor mice, largely of grass seeds, undoubtedly varied at times by the addition of berries and mushrooms and probably insects." When one comes upon them in the field they attempt to get out of the way by leaping although are not always able to direct their jumps in such a way as to make them beneficial for after making a dozen leaps a specimen may be very close to the starting point. At other times they bound away in the opposite direction from danger and are able to hide themselves very quickly and very securely. The winter is spent in a dormant condition beneath the ground. Although some observers have reported seeing specimens during mild weather of winter, others claim that often six months or more of the year is spent in the hibernating condition, making the observation that specimens plowed out in May in one case were still in a dormant state.

I have not seen any statement to the effect that these animals are injurious in any way, neither have I observed that they have any habits which would lead one to think that they have economic value. I consider them worthy of the sympathy of mankind, however, because of their unusual habits which are so different from other mammals in the region which they inhabit. They have numerous enemies among birds of prey and they do not appear to be very well prepared to evade cats and some other mammals that feed on the same kind of food.

Microtis pennsylvanicus (Ord). Meadow mouse. In his paper on An Economic Study of Field Mice, Lantz places this species at the head of the list. I am not sure of his reason for this or whether he intends by so doing to convey to his readers that it is of more importance from an economic standpoint than its relatives of the same genus, but as it is the most common short tailed mouse in Ohio we do not hesitate to accuse it of doing more damage along certain lines than any other rodent that shares with it the name which only has to be mentioned in order to designate its bearer as an enemy. The species may be known from other short tailed mice of the state by several characters. In the first place the tail is near two inches in length while in other short tailed mice the tail is less than an inch in length. Full grown specimens are larger and the color differs from others. Different specimens of the species vary in color more or less however, so this alone is not to be depended upon as a conclusive guide.

When a field grows up to June grass in the after part of the season and when winter comes this grass falls over and forms a carpet for the ground an ideal condition for meadow mice is produced. Here the mice form runways among the grass above the surface and in the ground beneath the surface so that they

can get out of the way easily in case of danger. If such a condition occurs in a waste field the mice live on roots largely and no noticeable damage results. In the burrows here and there quantities of dried grass is carried together and nests constructed where the adults spend much of their time and where the young are born. A brood of young usually consists of from four to six but they only remain under the direct care of the mother for a short time before they are able to go out and shift for themselves. Several broods are often produced in a season therefore and the species is enabled to multiply rapidly and thus it is a fact that a piece of ground with the desired conditions is very soon the home of large numbers of the rodents which in order to occupy the time and procure sufficient food are liable to get into all sorts of mischief. These conditions often exist in an orchard where the sod mulch system is practiced and if something is not done to protect the trees immense damage may result from the mice gnawing the bark from the trees near the ground, or sometimes just beneath the surface. These circumstances are illustrated in a recent bulletin by the Ohio Agricultural Experiment Station with a full treatment of the methods of protecting young trees.

Grain that is cut and placed in shocks in the field often receives more or less injury from this same mouse which is accused also of following in the burrows of moles and eating planted corn and other grains and seeds. In the case of wheat and other grain that is tied with twine the mice often get into the shocks and cut the bands, especially if this grain from any cause has to be left standing in the field longer than is usual.

Microtus pinetorum scalopsoides Audubon and Bachman. Northern Pine Mouse. An attractive species with a much shorter tail than the meadow mouse. The typical species is southern, the first recorded specimens having been taken in the pine forests of Georgia. Two varieties are recognized, *scalopsoides* and *auricularis*, both of which have a distribution that includes part of Ohio at least. I have seen a number of Ohio specimens from Hamilton and Madison counties, some of those from the first named county appear to be the specimens that were taken for the prairie meadow mouse by Brayton and are the basis of the recorded occurrence of that species in the state. I saw the specimens in the Cincinnati Society of Natural History museum. I cannot conclude that any of these specimens studied are the variety *auricularis* although Vernon Bailey records a specimen of this mouse from Brookville, Indiana, a few miles from Cincinnati. Further collecting may add *auricularis* to the list of Ohio mammals. The northern pine mouse appears quite different from the meadow mouse in the field but may inhabit similar situations. The fully adult specimens are browner and

sleeker and smaller in size and the tail is only about half as long as in that species. While collecting in Madison county a colony of the northern pine mouse was found in a pasture where the grass had grown rather high. As this was the 20th of November preparations had been made for winter evidently. I could not determine the number of specimens in the colony, but four of different ages were taken and there were evidences of others. Their nest was located under a split log lying with the flat side down and was composed of a quantity of soft grass with evidences of food material here and there. Runways led from the nest in various directions so that the mice had easy access to a supply of roots and other vegetable food in the vicinity. One of the specimens taken, a male, is adult and fully colored, a second specimen, also a male, is nearly adult size but the pelage is that of an immature individual, the other two are immature, not more than half grown.

Synaptomys cooperi Baird. Cooper Mouse. This species even has a shorter tail than the pine mouse and differs from all mice of the genus Microtus in having the upper front teeth groved. The species in the field has a grayish appearance with the under parts clearly lighter. It is quite widely distributed in the state and in places is common. It occurs in nearly the same situations as the meadow mouse and in one field at London, Madison county, all three of the short-tailed mice here considered were taken on the same date and within the space of a few square rods. In Summit county I located a nest of this species on top of the ground and anchored in a bunch of clover. This nest only contained two young which were observed often until they grew large enough to run; two young is common in the species which would indicate that it is not as prolific as the meadow mouse. The species is met with commonly by turning logs in fields and thin woods but is not confined to such situations.

Peromyscus leucopus noveboracensis (Fisher). Common White-footed Mouse. There are at least thirteen variations of *P. leucopus* recognized and named from different parts of North America. Most of eastern United States is included within this range and subspecies reach Arizona, Montana and Yucatan. The species was described by Rafinesque from specimens taken in western Kentucky, a region where two forms appear to intergrade making it necessary to apply the species name to specimens that are to some extent intermediate. Rafinesque's name has been applied to the form which has the more southern range while the form that is uniformly distributed over Ohio is given the subspecies name *noveboracensis*. Recently Osgood has published an exhaustive treatment of the genus Peromyscus giving full information regarding all subspecies. This paper is one of

the most complete so far published on a genus of North American mammals, and as the author examined more than 27000 specimens in preparing the work we may at once conclude that all matters concerned received full consideration.

The species has many attractive habits and is seldom injurious so has not received the ill will of man to the extent that many of the other mice have. A variety of food is acceptable and they are sometimes induced to enter buildings to feed but as a usual thing are woodland animals and are found around logs and stumps in such places. It is not uncommon however to come across specimens in fields or along fence rows wherever stumps, piles of rails and various kinds of rubbish are to be found. In the woods they feed on acorns and nuts and also eat many insects. In the fields they visit grain shocks but this habit seems not to be common like it is in the house mouse and the meadow mouse.

Until in recent years this has been the only white-footed mouse known in Ohio so it has been easy to make determinations but quite recently it has been found that one of the varieties of *P. maniculatus* reaches our territory and matters have become somewhat more complicated. Adult specimens of the species are decidedly larger than those of the variety of *maniculatus* but when it comes to the young in gray pelage it is easy to be mistaken. It is soon observed that when one begins collecting white-footed mice in any locality in the state he soon brings together a large variety of coloration; not many distinct colors but specimens with grays and browns variously distributed over the body. This condition is almost entirely due to the age of the specimens; the young are gray and the fully adults are yellowish brown above with pure white under parts while specimens in the process of changing from the young to the adult pelage combine these colors with no apparent regard for system.

This species appears to care for its young better than other mice and it is not uncommon to observe it undertaking to move these to places of safety when danger threatens. It is a popular species under domesticated conditions readily adapting itself to circumstances.

Peromyscus maniculatus bairdi (Hoy and Kennicott) Prairie White-footed Mouse. The type locality for *P. maniculatus* is Labrador and the typical species is confined to that latitude as far west as the Mississippi River, but varieties to the number of thirty-five are recognized and one or more of these are to be found in many localities throughout North America. The variety *bairdi* was first taken at Bloomington, Illinois but is known at the present time to range from central Kansas

on the west nearly to central Ohio on the east. The first specimens recorded for the state were taken at London, Madison county where a male and female and three young were procured in 1906. These specimens were all together under a log but there was no indication of a nest near at hand. The prairie white-footed mouse is distinctly smaller than the common white-footed species, color darker, ears and feet smaller and the tail much shorter. When one has an acquaintance with both they appear very distinct, but the difference is not conspicuous enough to prevent confusion at all times. Osgood includes all of western Ohio within the range of this mouse.

In most of the recent publications including this variety it is treated as *Peromyscus michiganensis* (Audubon and Bachman), but Osgood shows that this is not correct.

Oryzomys palustris (Harlan). Rice-field Mouse. This animal is called a rat by some authors but as the only difference that exists between a rat and a mouse is a matter of size, it is just as acceptable to call it a mouse as many do. In size close to that of a half grown common rat and appearing much like that animal, although the tail is longer, the coloration browner and there is a white fringe of hairs on the lower part of the ear.

The Ohio records of this species are rather meager but there is conclusive evidence that it once inhabited the state, even though it may not at the present time. Brayton has the following to say: "It has been identified by Mr. Frank Langdon with some hesitation, on the strength of the posterior half of a small rat taken from the stomach of a hawk at Madisonville, Ohio." Brayton afterward examined the specimen and found the feet and tail answered the description of the rice-field mouse in detail.

Professor W. C. Mills while engaged in directing excavations at Baum Village Site near Chillicothe, Ohio, procured dozens of the skulls of this species at different depths. He states that other parts of the skeletons were observed and that it appeared as if the mice had died in their burrows. There is no way of deciding as to the age of these remains and so it cannot be stated what the relation to their surroundings might have been. I give these peculiar records because it is desired that any one in a position to give information on the rice-field mouse in Ohio may know the facts and if possible aid us in procuring more convincing proof.

Mus musculus Linnaeus. House Mouse. The members of the genus Mus which includes the house mouse, brown rat and black rat are all introduced into America and are the very worst of household pests. They are likely to multiply rapidly in any place where food products are stored or where they can find

anything to eat. The house mouse is distributed in most inhabited regions of the world. It was introduced into America from Europe almost with the first settlers from the latter country. Its original home is said to be southern Asia from whence it has been carried on ship board to all the land areas and then across country by different modes of travel until it has reached its present distribution. This species, although so widely distributed, is uniform in its characters which designate it and differences in environment seem to change it in no perceivable way, as if it has developed characters which are perfectly fitted to the conditions under which the various specimens live. An interesting comparison along this line may be made with some of the American species of white-footed mice. A species that is widely distributed over the continent exists in thirty-five different recognized varieties but the house mouse distributed all over the world is *Mus musculus* everywhere.

Species that may be looked for in Ohio are the following:

Zapus insignis Miller. Woodland Jumping Mouse. Has been taken in western Pennsylvania and may be expected in eastern Ohio. Size larger than the meadow jumping mouse, ears longer and coloration paler. Premolar teeth are present in the other species of jumping mice but absent in this one. The species is an inhabitant of deep woods rather than meadows and fields.

Microtus austerus (LeConte). Prairie Meadow Mouse. Reported from Indiana, and possibly is a resident of western Ohio. Brayton reported this species, but as near as can be determined his specimens were the northern pine mouse. It may be known from the common meadow mouse by the slightly shorter tail and the grayer coloration as well as by the pelage appearing coarser.

Evotomys gapperi (Vigors). Red-backed Mouse. Known from Pennsylvania and if procured in Ohio the northeastern part of the state most likely will furnish it. The species is said to inhabit low woodlands and swamps and to remain in such situations nearly all the time. The species is a near relative of the common meadow mouse, but smaller and with a chestnut color which usually serves to distinguish it readily.

Peromyscus nuttalli (Harlan). Northern Golden Mouse. Specimens are known from central Kentucky and Rev. W. F. Henninger believes it is to be found in southern Ohio. The color of this mouse at all ages is suggested by the name and is a distinguishing characteristic. It is reported as partial to low ground, and, as a usual thing, is not abundant anywhere within its range.

MEDICINAL PLANTS OF OHIO.

FREDA DETMERS.

(*Continued from page* 60.)

Papaveraceae.

Sanguinaria canadensis L. Blood root. (U. S. P.) (Ec.) (Hom.) *Rhizome.*

Stylophorum diphyllum Nutt. Celandine Poppy. (Ec.) *Rhizome.*

Chelidonium majus L. Celandine. (Ec.) *Plant.*

Argemone mexicana L. Mexican or Prickly Poppy. (Ec.) *Plant.*

Fumariaceae.

Bicuculla canadensis (Goldie) Millsp. (*Dicentra canadensis* DC.). Squirrel corn. (Ec.) (Hom.) *Tubers.*

Cruciferae.

Bursa bursa-pastoris (L.) Britt. (*Capsella bursa-pastoris* Moench). Shepherd's Purse. (Ec.) *Dried plant.*

Brassica alba (L.) Boiss. (*Sinapis alba* L.) White Mustard. (U. S. P.) (Ec.) (Hom.) *Seed.*

Brassica nigra (L.) Koch. (*Sinapis nigra* L.) Black Mustard. (U. S. P.) (Ec.) (Hom.) *Seed.*

Sisymbrium officinale Scop. Hedge Mustard. (Ec.) *Seeds* and *herb.*

Sarraceniales.

Sarraceniaceae.

Sarracenia purpurea L. Pitcher Plant. (Ec.) (Hom.) *Root.*

Droseraceae.

Drosera rotundifolia L. Round-leaved Sundew. (Ec.) (Hom.) *herb.*

Rosales.

Penthoraceae.

Penthorum sedoides L. Ditch Stone crop. (Ec.) (Hom.) *Herb.*

Saxifragaceae.

Heuchera americana L. Alum Root, American Sanicle. (Ec.) *Root.*

Hydrangeaceae.

Hydrangea arborescens L. Seven Barks, Hydrangea. (Ec.) (Hom.) *Root.*

Philadelphus coronarius L. Garden Syringa, Mock Orange. (Hom.) *Flowers.*

Grossulariaceae.

Ribes rubrum L. Red Currant. (Ec.) *Fruit.*
Ribes nigrum L. Black Currant cult. (Ec.) *Fruit.*
Ribes floridum L'Her. Wild Black Currant. (Ec.) *Fruit.*

Hamamelidaceae.

Hamamelis virginiana L. Witch Hazel. (U. S. P.) (Ec.) (Hom.) *Leaves coll. in autumn, bark and twigs.*
Liquidambar styriciflua L. Sweet Gum. (Ec.) *Sap.*

Rosaceae.

Spiraea tomentosa L. Hard hack. (Ec.) (Hom.) *Herb.*
Porteranthus trifoliatus (L.) Britt. (*Gillenia trifoliata* Moench.) Indian Physic. (Ec.) *Bark of Rhizome.*
Porteranthus stipulatus (Muhl.) Britt. (*Gillenia stipulata* Nutt.) (Ec.) *Bark of rhizome.*
Rubus odoratus L. Purple-flowering Raspberry (Ec.) *Fruit.*
Rubus strigosus Mx. Wild Red Raspberry (U. S. P.) (Ec.) *Leaves and fruit.*
Rubus occidentalis L. Wild Black Raspberry (U. S. P.) (Ec.) *Leaves and fruit.*
Rubus idaeus L. cult. Raspberry. (U. S. P.) (Ec.) *Fruit.*
Rubus nigrobaccus Bailey. High Bush Blackberry. (U. S. P.) *Bark of root.*
Rubus villosus Ait. Dewberry. (U. S. P.) (Ec.) *Fruit and bark of root.*
Rubus canadensis L. Dewberry (Ec.) *Fruit and bark of root.*
Fragaria vesca L. Wood Strawberry. (Ec.) (Hom.) *Fruit, leaves and root.*
Potentilla canadensis L. (Hom.) *Root.*
Geum virginianum L. Rough Avens. (Ec.) *Rhizome and roots.*
Geum rivale L. Purple or Water Avens. (Ec.) *Rhizome and roots.*
Ulmaria ulmaria (L.) Barnh. (*Spiraea ulmaria* L.) Queen of the Meadow (Ec.). *Herb.*
Agrimonia striata Mx. Agrimony. (Ec.) *Whole plant.*
Agrimonia parviflora Sol. Sweet scented Agrimony. (Ec.) *Whole plant.*
Rosa canina L. and other related indigenous species. (Ec.) (Hom.) *Ripe fruit.*
Rosa centifolia L. cult. Hundred-leaved Rose. (Ec.) (Hom.) *Petals.*
Rosa gallica L. cult. Provence Rose. (U. S. P.) (Ec.) *Petals.*

Pomaceae.

Sorbus americana Marsh. American Mountain Ash. (Ec.) *Ripe fruit.*
Sorbus sambucifolia Roem. Western Mountain Ash. (Ec.) *Ripe fruit.*

Malus coronaria (L.) Mill. Crab Apple. (Ec.) Ripe fruit.
Malus malus (L.) Britt. (*Pyrus malus*). Apple (Ec.) (Hom.) *Bark and fruit.*
Aronia arbutifolia (L.) Medic. (*Pyrus arbutifolia* Lf.) Red Choke-berry. (Ec.) *Ripe fruit.*
Crataegus oxyacantha L. Hawthorn. (Ec.) Bark and fruit.

Drupaceae.

Prunus domestica L. Plum cult. (U. S. P.) (Ec.) *Fruit.*
Prunus virginiana L. Choke Cherry (Ec.) *Fruit.*
Prunus serotina Ehrh. (*Prunus virginiana* L.) Wild Black Cherry (U. S. P.) (Ec.) *Bark coll. in Autumn.*
Amygdalus persica L. (*Persica vulgaris*). Peach cult. (Ec.) (Hom.) *Leaves, kernels and bark of twigs.*

Fabaceae.

Gymnocladus dioica (L.) Koch (*G. canadensis* Lam.) Kentucky Coffee Tree. (Ec.) (Hom. *Seeds and pulp of the pods.*
Cassia marilandica L. American Senna. (Ec.) *Leaves.*
Cercis canadensis L. Red bud or Judas Tree. (Ec.) *Seeds and pulp of the pods.*
Baptisia tinctoria R. Br. Wild Indigo. (Ec.) *Root and leaves.*
Trifolium pratense L. Red clover. (Ec.) (Hom.) *Blossoms.*
Melilotus officinalis Willd. Yellow Sweet Clover. (Ec.) (Hom.) *Leaves and flowering tops.*
Melilotus alba Lam. White Sweet Clover. (Ec.) (Hom.) *Leaves and flowering tops.*
Psoralea melilotoides Mx. Snake Root. (Ec.) *Root and leaves.*
Tephrosia virginiana Pers. Turkey Pea. Goat's Rue. (Ec.) *Root.*
Robinia pseudacacia L. Black Locust. (Ec.) (Hom.) *Bark and leaves.*

Geraniales.

Linaceae.

Linum usitatissimum L. Flax. (U. S. P.) (Ec.) *Seed.*

Oxalidaceae.

Oxalis acetosella L. Wood-sorrel. (Hom.) *Plant.*
Oxalis violacea L. Violet wood-sorrel. (Ec.) *Herb.*
Oxalis stricta L. Upright Yellow Wood-sorrel. (Ec.) *Herb.*
Oxalis corniculata L. Procumbent Yellow Wood-sorrel. (Ec.) *Herb.*

Geraniaceae.

Geranium maculatum L. Wild Geranium. (U. S. P.) (Ec.) (Hom.) *Rhizome.*
Geranium robertianum L. Herb Robert. (Ec.) (Hom.) *Rhizome.*

Rutaceae.

Xanthoxylum americanum Mill. Prickly Ash. (U. S. P.) (Ec.) (Hom.) *Bark.*

Ptelea trifoliata L. Shrubby Trefoil. (Ec.) (Hom.) *Bark of the root.*

Simarubaceae.

Ailanthus glandulosa Desf. Chinese Tree of Heaven. (Ec.) *Inner bark.*

Polygalaceae.

Polygala senega L. Senega Snake-root. (U. S. P.) (Ec.) (Hom.) *Root.*

Euphorbiaceae.

Euphorbia maculata L. Spotted spurge (Ec.) *Bark of root.*

Euphorbia corollata L. Flowering Spurge. (Ec.) (Hom.) *Bark of the root.*

Euphorbia cyparissias L. Cypress Spurge. (Hom.) *Bark of the root.*

Callitrichaceae.

Callitriche palustris L. (*C. verna* L.) Vernal Water Starwort. (Ec.) *Plant.*

Sapindales.

Anacardiaceae.

Rhus typhina L. Staghorn Sumac. (Ec.) *Bark of the root.*

Rhus glabra L. Smooth Sumac. (U. S. P.) (Ec.) (Hom.) *Fresh fruit and bark of root.*

Rhus vernix L. (*R. venenata* DC.) Poison Oak. (Ec.) (Hom.) *Leaves.*

Rhus radicans L. (*R. toxicodendron* L.) (U. S. P.) (Ec.) (Hom.) *Leaves.*

Rhus aromatica Ait. Fragrant Sumac. (Ec.) *Bark of the root.*

Ilicaceae.

Ilex opaca Ait. American Holly. (Ec.) (Hom.) *Leaves.*

Ilex verticillata Gray. Black Alder. (Ec.) *Bark and berries.*

Celastraceae.

Euonymus atropurpureus Jacq. Wahoo, Burning Bush. (U. S. P.) (Ec.) (Hom.) *Bark of the root.*

Celastrus scandens L. Climbing Bitter-sweet. (Ec.) *Bark.*

Hippocastanaceae.

Aesculus hippocastanum L. Horse chestnut. (Ec.) (Hom.) *Bark and fruit.*

Aesculus glabra Willd. Ohio or Fetid Buckeye. (Ec.) (Hom.) *Fruit.*

Balsaminaceae.

Impatiens biflora Walt. (*I. fulva* Nutt.) Spotted Touch-me-not, Jewel Weed. (Ec.) *Herb.*

Impatiens aurea Muhl. (*I. pallida* Nutt.) Pale Touch-me-not. (Ec.) *Herb.*

Rhamnales.

Rhamnaceae.

Ceanothus americanus L. Red-root, New Jersey Tea. (Ec.) *Root, root bark and leaves.*

Vitaceae.

Vitis vinifera L. Grape cult. (U. S. P.) (Ec.) (Hom.) *Juice of fruit.*

Parthenocissus quinquefolia (L.) Planch. (*Ampelopsis quinquefolia* Mx.) Wood-bine, Virginian Creeper. (Ec.) *Bark and young leafy twigs.*

Malvales.

Tiliaceae.

Tilia sp. Linden. Basswood. (Ec.) (Hom.) *Flowers.*

Malvaceae.

Althaea officinalis L. Marsh Mallow. (Ec.) *Flowers, capsule and root.*

Althaea rosea Cav. Hollyhock. (Ec.) *Flowers, capsule and root.*

Malva sylvestris L. Common Mallow. (Ec.) *Flowers, capsule and root.*

Malva rotundifolia L. Low Mallow. Cheeses. (Ec.) *Flowers, capsule and root.*

Abutilon abutilon Rusby. (*Abutilon avicennae* Gaertn.) (Ec.) *Flowers, capsule and root.*

Hibiscus moscheutos L. Swamp Rose Mallow. (Ec.) *Flowers, capsule and root.*

Parietales.

Hypericaceae.

Hypericum perforatum L. St. John's Wort. (Ec.) (Hom.) *Leaves and flowering tops.*

Cistaceae.

Helianthemum canadense (L.) Mx. (*Cistus canadensis* L.) Frost weed. (Ec.) *Plant.*

Violaceae.

Viola pedata L. Bird's foot Violet. (Ec.) *Fresh plant.*

Viola odorata L. cult. (Ec.) (Hom.) *Plant.*

Viola tricolor L. Pansy. (Ec.) (Hom.) *Plant.*

Passifloraceae.

Passiflora lutea L. Passion Flower. (Ec.) *Root and stem base.*

Thymeleales.

Thymeleaceae.

Dirca palustris L. Leather wood. (Ec.) (Hom.) *Bark.*

Myrtales.

Lythraceae.

Lythrum alatum Ph. Wing-angled loosestrife. (Ec.) *Plant.*
Lythrum salicaria L. Purple Loosestrife. (Ec.) *Plant.*
Parsonia petiolata (L.) Rusby. (*Cuphaea viscosissima* Jacq.) Blue Wax-weed. (Ec.) *Plant.*

Onagraceae.

Onagra biennis (L.) Scop. (*Oenothera biennis* L.) Evening Primrose. (Ec.) (Hom.) *Root, bark and leaves.*

Umbellales.

Araliaceae.

Aralia sp. (Ec.) *Bark.*
Panax quinquefolium L. (*Aralia quinquefolia* Decs. and Planch.) Ginseng. (Ec.) (Hom.) *Root.*

Umbelliferae.

Sanicula marylandica L. Black Snake-root. (Ec.) *Root.*
Washingtonia longistylis (Torr.) Britt. (*Osmorrhiza longistylis* DC.) Sweet Cicely. (Ec.) (Hom.) *Root.*
Apium graveolens L. Celery cult. (Ec.) *Plant and seed.*
Apium petroselinum L. (*Petroselinum sativum* Hoffm.) Parsley cult. (Ec.) (Hom.) *Root.*
Cicuta maculata L. (*Conium maculatum* L.) Poison or Water Hemlock. (Ec.) (Hom.) *Mature green fruit.*
Carum carvi L. Caraway seed. (U. S. P.) (Ec.) (Hom.) *Dried fruit.*
Sium cicutaefolium Gmel. (*Sium lineare* Mx.) Hemlock Water-parsnip. (Ec.) *Mature green fruit.*
Thaspium trifoliatum aureum (Nutt.) Britt. Meadow Parsnip. (Hom.) *Whole plant.*
Angellica atropurpurea L. (*Archangelica atropurpurea* Hoffm.) Great or Purple-stemmed Angelica. (Ec.) *Root, herb and seed.*
Angellica villosa (Walt) B. S. P. (*Archangelica hirsuta* T. & G.) Pubescent Angellica. (Ec.) *Root, herb and seed.*
Heracleum lanatum L. Alum-root. (Ec.) *Root.*
Daucus carota L. Wild Carrot. (Ec.) *Root and fruit.*

Cornaceae.

Cornus florida L. Flowering Dogwood. (Ec.) (Hom.) *Bark.*
Cornus circinata L'Her. Round-leaved Dogwood. (Ec.) (Hom.) *Bark.*
Cornus amonum Mill. Swamp Dog-wood. (Ec.) (Hom.) *Bark.*

Ericales.

Pyrolaceae.

Pyrola rotundifolia L. Shin-Leaf, False Winter Green. (Ec.) (Hom.) *Herb.*
Pyrola elliptica Nutt. Shin Leaf. (Ec.) *Herb.*
Pyrola secunda L. (Ec.) *Herb.*
Chimaphila maculata Pursh. Spotted Winter Green. (Ec.) *Plant.*
Chimaphila umbellata (L.) Nutt. Princes Pine, Winter Green. *Plant.*

Monotropaceae.

Monotropa uniflora L. Indian Pipe. (Hom.) *Root.*

Ericaceae.

Rhododendron maximum L. Great Laurel, (Ec.) *Leaves.*
Kalmia latifolia L. Mountain Laurel, Calico Bush. (Ec.) (Hom.) *Leaves.*
Oxydendron arboreum DC. Sour Wood, Sorrel Tree. (Ec.) *Leaves.*
Epigaea repens L. Trailing Arbutus (Ec.) (Hom.) *Leaves.*
Gaultheria procumbens L. Winter Green. (Ec.) *Leaves.*
Arctostaphylos uva-ursi (L.) Spreng. (*Uva-ursi.*) Bearberry. (U. S. P.) (Ec.) (Hom.) *Leaves.*

Vacciniaceae.

Gaylussacia frondosa T. & G. Blue Whortle Berry. (Ec.) *Fruit and root.*
Gaylussacia resinosa T. & G. Black Huckleberry. (Ec.) *Fruit and root.*
Oxycoccus macrocarpus (Ait.) Pers. (*Vaccinium macrocarpon* Ait.) (Ec.) *Fruit and root.*

Primulaceae.

Anagallis arvensis L. Red or Scarlet Pimpernel. (Ec.) *Leaves.*

Ebenales.

Ebenaceae.

Diospyros virginiana L. Persimmon. (Ec.) *Bark and unripe fruit.*

Gentianales.

Oleaceae.

Fraxinus americana L. White Ash. (Ec.) (Hom.) *Bark.*
Fraxinus nigra Marsh. (*F. sambucifolia* Lam.) Black Ash. (Ec.) *Bark.*
Chionanthus virginicus L. Fringe tree. (Ec.) *Root bark.*
Ligustrum vulgare L. Privet. (Ec.) *Leaves.*

Loganiaceae.

Spigelia marylandica L. Indian Pink. (U. S. P.) (Ec.) (Hom.) *Rhizome and roots.*

Gentianaceae.

Sabbatia angularis Pursh. Rose Pink. (Ec.) *Herb.*
Gentiana crinita Froel. Fringed Gentian. (Ec.) *Root.*
Gentiana quinquefolia L. Ague Weed. (Ec.) *Root.*
Gentiana andrewsii Griseb. Closed or Blind Gentian. (Ec.) *Root.*
Frasera caroliniensis Walt. American Colombo. (Ec.) (Hom.) *Root.*

Menyanthaceae.

Menyanthes trifoliata L. Buck Bean, Bog Bean. (Ec.) (Hom.) *Leaves and rhizome.*

Apocynaceae.

Vinca minor L. Periwinkle, Myrtle. (Ec.) *Rhizome.*
Apocynum androsaemifolium L. Spreading Dogbane. (Ec.) *Root collected in Autumn.*
Apocynum cannabinum L. Indian Hemp. (U. S. P.) (Ec.) (Hom.) *Root collected in Autumn.*

Asclepiadaceae.

Asclepias tuberosa L. Pleurisy Root. (Ec.) *Root.*
Asclepias incarnata L. Swamp Milkweed. (Ec.) *Root.*
Asclepias syriaca L. (*A. cornuti Des.*) Milkweed. (Ec.) *Root.*

Polemoniales.

Convolvulaceae.

Convolvulus arvensis L. Bindweed. (Hom.) *Root, leaves and flowers.*
Convolvulus scammonia L. Scammony. (U. S. P.) (Ec.) (Hom.) *Resinous exudation from the living root.*

Polemoniaceae.

Polemonium reptans L. Greek Valerian. (Ec.) (Hom.) *Root.*

Hydrophyllaceae.

Hydrophyllum virginicum L. Water-leaf. (Hom.) *Plant.*

Boraginaceae.

Cynoglossum officinale L. Hound's Tongue. (Ec.) (Hom.) *Leaves and root.*

Mertensia virginica DC. Virginian Lungwort. (Ec.) *Leaves and root.*

Lithospermum officinale L. Common Gromwell, Wheat Thief. (Ec.) *Roots and seeds.*

Lithospermum canescens Lehm. Yellow Puccoon. (Ec.) *Roots and seeds.*

Onosmodium carolinianum (Lam.) DC. Shaggy False Gromwell. (Ec.) *Roots and seeds.*

Echium vulgare L. Viper's Bugloss. (Ec.) *Leaves and root.*

Symphytum officinale L. Comfrey. (Ec.) *Root.*

Verbenaceae.

Verbena urticaefolia L. White or Nettle-leaved Vervain. (Ec.) (Hom.) *Root.*

Verbena hastata L. Blue Vervain. (Ec.) (Hom.) *Root.*

Labiatae.

Scutellaria lateriflora L. Mad-dog Skull-Cap. (U. S. P.) (Ec.) (Hom.) *Herb.*

Marrubium vulgare L. Hoarhound. (U. S. P.) (Ec.) *Leaves and tops.*

Nepeta cataria L. (*Cataria vulgaris* Moench). Catnip. Catmint. (Ec.) (Hom.) *Leaves and flowering tops.*

Glecoma hederacea L. (*Nepeta glecoma* Benth). Ground Ivy. (Ec.) (Hom.) *Plant.*

Prunella vulgaris L. (*Brunella vulgaris* L.) Self-heal. (Ec.) (Hom.) *Herb.*

Leonurus cardiaca L. Motherwort. (Ec.) *Tops and leaves.*

Lamium album L. White Dead-Nettle. (Hom.) *Herb.*

Salvia officinalis L. Sage cult. (U. S. P.) (Ec.) (Hom.) *Leaves.*

Salvia lyrata L. Lyre-leaved Sage. (Ec.) *Leaves.*

Monarda didyma L. Oswego Tea. (Ec.) *Leaves and tops.*

Monarda fistulosa L. Wild Bergamot. (Ec.) *Leaves and tops.*

Hedeoma pulegioides (L.) Pers. Pennyroyal. (U. S. P.) (Ec.) (Hom.) *Leaves and tops.*

Melissa officinalis L. Bee Balm. (Ec.) (Hom.) *Leaves and tops.*

Origanum vulgare L. Wild Majorum. (Ec.) (Hom.) *Herb.*

Koellia pilosa (Nutt.) Britt. (*Pycnanthemum pilosum* Nutt.) Basil. (Ec.) *Herb.*

Koellia incana (L.) Kuntze. (*Pycnanthemum incanum* Mx.) Wild Basil. (Ec.) *Leaves and tops.*

Thymus vulgaris L. Thyme. (Ec.) (Hom.) *Herb.*

Cunila origanoides (L.) Britt. American Dittany. (Ec.) *Herb.*

Lycopus virginicus L. Bugle-weed. (Ec.) (Hom.) *Herb.*

Mentha spicata L. (*M. viridis* L.) Spearmint. (U. S. P.) (Ec.) (Hom.) *Leaves and flowering tops.*

Mentha piperita Sm. Peppermint. (U. S. P.) (Ec.) (Hom.) *Leaves and flowering tops.*

Collinsonia canadensis L. Horse-balm. (Ec.) (Hom.) *Plant with root.*

Solanaceae.

Solanum nigrum L. Garden Nightshade. (Ec.) (Hom.) *Shoots.*

Solanum carolinense L. Horse-nettle. (Ec.) *Root and fruit.*

Solanum dulcamara L. Bitter sweet. (Ec.) (Hom.) *Shoots.*

Lycopersicon lycopersicon (L.) Karst. (*L. esculentum* Millsp.) Tomato. (Ec.) Young branches.

Lycium vulgare (Ait. f.) Dunal. Matrimony Vine. (Ec.) *Young branches.*

Datura stramonium L. Jamestown Weed, Thorn Apple. (U. S. P.) (Ec.) (Hom.) *Seeds and leaves.*

Nicotiana tabacum L. Tobacco cult. (Ec.) *Leaves.*

Scrophulariaceae.

Verbascum thapsus L. Mullein. (Ec.) (Hom.) *Leaves and tops.*

Linaria linaria (L.) Karst. (*L. vulgaris* Mill.) Snap Dragon. Toad Flax. (Ec.) *Plant.*

Scorphularia marylandica L. (S. *nodosa* var. *marylandica* Gray). Figwort, Heal all. (Ec.) (Hom.) *Leaves, tops and roots.*

Chelone glabra L. Snakehead, Turtlehead. (Ec.) *Herb.*

Gratiola virginiana L. Hedge-hyssop. (Ec.) *Entire plant.*

Veronica officinalis L. Common Speedwell. (Ec.) *Tops and leaves.*

Veronica peregrina L. Purslane Speedwell. (Ec.) *Tops and leaves.*

Leptandra virginica Nutt. Culver's-root. (U. S. P.) (Ec.) (Hom.) *Rhizome and rootlets.*

Digitalis purpurea L. Foxglove. (U. S. P.) (Ec.) (Hom.) *Leaves from plants of second year's growth.*

Dasystoma pedicularia (L.) Benth. (*Gerardia pedicularia* L.) False Foxglove. (Ec.) *Herb.*

Orobanchaceae.

Leptamnium virginianum (L.) Raf. (*Orobanche virginiana* L.) Beech-drops. (Hom.) *Fresh plant.*

Bignoniaceae.

Tecoma radicans (L.) DC. Trumpet-flower. (Hom.) *Root.*

Catalpa catalpa (L.) Karst. Catalpa. (Ec.) *Bark.*

Plantaginiales.

Plantaginiaceae.

Plantago major L. Plantain. (Ec.) (Hom.) *Roots and leaves.*

Plantago lanceolata L., P. cordata Lam. and **P. arenaria Wald. & K.** Plantain. (Ec.) *Roots and leaves.*

Rubiales.

Rubiaceae.

Cephalanthus occidentalis L. Button-bush. (Ec.) *Bark.*
Mitchella repens L. Partridge Berry. (Ec.) (Hom.) *Plant.*
Galium aparine L. Cleavers. Bed straw. (Ec.) (Hom.) *Herb.*
Galium triflorum Mx., G. circaezans Mx., G. tinctorium L. and **G. trifidum L.** (Ec.) *Herb.*

Caprifoliaceae.

Sambucus canadensis L. Elder. (Ec.) (Hom.) *Inner bark and flowers.*
Viburnum opulus L. Cranberry-tree. (U. S. P.) (Ec.) (Hom.) *Bark.*
Viburnum prunifolium L. Black Haw. (U. S. P.) (Ec.) (Hom.) *Bark.*
Triosteum perfoliatum L. Fever-wort. (Ec.) (Hom.) *Bark of root.*
Triosteum augustifolium L. Narrow-leaved Horse Gentian. (Ec.) *Bark of root.*
Lonicera caprifolium L. Italian Honey-suckle. (Ec.) *Flowers.*
Diervilla diervilla (L.) MacM. Bush Honey-suckle. (Ec.) *Root and leaves.*

Valerianales.

Valerianaceae.

Valeriana officinalis L. Garden Valerian. (U. S. P.) (Ec.) (Hom.) *Rhizome.*

Dipsacaceae.

Dipsacus sylvestris Huds. Wild Teasel. (Hom.) *Fresh plant in flower.*

Campanulales.

Cucurbitaceae.

Cucurbita pepo L. Pumpkin cult. (U. S. P.) (Ec.) (Hom.) *Seed.*
Cucurbita maxima Duchesne. Gourd cult. (Ec.) *Seed.*
Cucumis sativus L. Cucumber cult. (Ec.) *Seed.*

Campanulaceae.

Lobelia cardinalis L. Cardinal Flower. (Ec.) (Hom.) *Leaves and tops.*
Lobelia syphilitica L. Great Lobelia. (Ec.) (Hom.) *Leaves and tops.*
Lobelia inflata L. Indian Tobacco. (U. S. P.) (Ec.) (Hom.) *Leaves and tops.*
Lobelia kalmii L. Brook or Kalm's Lobelia. (Ec.) *Leaves and tops.*

Cichoriaceae.

Cichorium intybus L. Chicory. (Ec.) *Root.*
Taraxacum taraxacum (L.) Karst. (*T. officinale* Weber). (U. S. P.) (Ec.) (Hom.) *Root.*
Lactuca virosa L. and other species of uncultivated Lettuce. (U. S. P.) (Ec.) (Hom.) *Flowering herb.*
Lactuca sativa L. Garden Lettuce. (Hom.) *Stalk.*
Hieracium venosum L. Hawkweed. Rattlesnake Weed. (Ec.) *Root and leaves.*
Hieracium scabrum Mx. Rough Hawkweed. (Ec.) *Root and leaves.*
Hieracium gronovii L. Hairy Hawkweed. (Ec.) *Root and leaves.*
Nabalus albus Hook. Rattlesnake Root. (Ec.) (Hom.) *Plant.*

Ambrosiaceae.

Xanthium spinosum L. Spiny Clot-bur. (Ec.) (Hom.) *Plant.*
Ambrosia trifida L. Great Ragweed, Horse Weed. (Ec.) *Leaves.*
Ambrosia artemisiaefolia L. Ragweed. (Ec.) *Leaves.*

Compositae.

Vernonia noveboracensis (L.) Willd. Ironweed. (Ec.) *Root.*
Vernonia fasciculata Mx. Iron-weed. (Ec.) *Root.*
Eupatorium purpureum L. Joe-Pye-weed. (Ec.) (Hom.) *Root.*
Eupatorium sessilifolium L. Upland Boneset. (Ec.) *Root.*
Eupatorium perfoliatum L. Boneset. (U. S. P.) (Ec.) (Hom.) *Leaves and flowering tops.*
Eupatorium ageratoides L. White Snake-root. (Ec.) *Root.*
Lacinaria squarrosa (L.) Hill. (*Liatris squarrosa* Willd.) Blazing Star. (Hom.) *Root.*
Grindelia squarrosa (Ph.) Dunal. Broad-leaved Gum Plant. (U. S. P.) (Ec.) (Hom.) *Leaves and flowering tops.*
Chrysopsis graminifolia (Mx.) Nutt. Grass-leaved Golden Aster. (Ec.) *Leaves and blossoms.*
Solidago serotina gigantea (Ait.) A. Gr. Golden Rod. (Ec.) (Hom.) *Leaves and blossoms.*
Solidago rigida L. Rigid Golden Rod. (Ec.) (Hom.) *Leaves and blossoms.*
Aster cordifolius L. Heart-leaved Aster. (Ec.) *Root.*
Aster novae-angliae L. New England Aster. (Ec.) *Root.*
Aster puniceus L. Purple stemmed Aster. (Ec.) *Root.*
Erigeron philadelphicus L. Daisy Fleabane. (Ec.) *Plant.*
Erigeron annuus (L.) Pers. Sweet Scabious. (Ec.) *Plant.*
Leptilon canadense (L.) Britt. (*Erigeron canadense* L.) Canada Fleabane. (Ec.) (Hom.) *Plant.*
Antennaria plantaginifolia (L.) Rich. (Ec.) *Leaves.*
Gnaphalium obtusifolium L. Sweet or White Balsam. (Ec.) (Hom.) *Herb.*

Inula helenium L. Elecampane. (U. S. P.) (Ec.) (Hom.) *Root.*
Polymnia uvedalia L. Bear's-foot, Leaf-cup. (Ec.) (Hom.) *Root.*
Silphium perfoliatum L. Cup-plant. (Ec.) *Root.*
Rudbeckia laciniata L. Tall or Green-headed Cone Flower. (Ec.) *Herb.*
Brauneria purpurea (L.) Britt. (*Rudbeckia purpurea* L.) Purple Cone-flower. (Ec.) *Root.*
Helianthus annuus L. Sun Flower. (Ec.) (Hom.) *Seeds and stems.*
Helianthus tuberosus L. Jerusalem Artichoke. (Ec.) *Seeds and stems.*
Verbesina virginica L. Crown Beard. (Ec.) *Leaves and tops.*
Verbesina helianthoides Nutt. (*Actinomeris helianthoides* Nutt.) Sunflower Crown beard. (Ec.) *Seeds and stems.*
Bidens cernua L., B. connata Willd., B. frondosa L. and **B. bipinnata L.** Spanish Needles, Beggar's Ticks. (Ec.) *Root and seeds.*
Helenium autumnale L. Sneeze-weed. (Ec.) *Plant.*
Helenium tenuifolium Nutt. Five-leaved Sneeze-weed. (Ec.) *Plant.*
Achillea millefolium L. Yarrow. (Ec.) (Hom.) *Plant.*
Anthemis cotula L. (*Maruta cotula DC.*) Mayweed, Dog Fennel. (Ec.) *Herb.*
Anthemis arvensis L. Corn or Field Chamomile (Ec.) *Flower heads.*
Matricaria chamomilla L. German Chamomile. (U. S. P.) (Ec.) *Flower heads.*
Tanacetum vulgare L. Tansy. (U. S. P.) (Ec.) (Hom.) *Leaves and tops.*
Artemisia vulgaris L. Common Mugwort. (Ec.) *Root.*
Tussilago farfara L. Colt's Foot. (Hom.) *Plant.*
Erechtites hieracifolia (L.) Raf. Fire weed. (Ec.) (Hom.) *Plant and oil.*
Senecio obovatus Muhl. Golden Ragwort. (Ec.) *Herb.*
Senecio aureus L. Golden Ragwort. (Ec.) (Hom.) *Herb.*
Arctium lappa L. Burdock. (U. S. P.) (Ec.) (Hom.) *Roots.*
Carduus arvensis L. Robs. (*Cirsium arvense* Scop.) Canada Thistle. (Ec.) *Root.*
Centaurea cyanus L. Corn flower. (Ec.) *Leaves and flowering heads.*

A LIST OF THE FERNS OF MAHONING COUNTY WITH SPECIAL REFERENCE TO MILL CREEK PARK.

EARNEST W. VICKERS.

Lying toward the north-eastern corner of the state and belonging to a group known as the Highland Counties of Ohio, Mahoning presents variations of soil and surface which find natural expression in its flora.

The erosions of the Mahoning River which flows up the west side of the County and again down across the north-east corner, as well as numerous smaller streams have left steep banks, glens, ledges and cliffs and in the case of Mill Creek—which gives the park its name—at Lautermain Falls, near Youngstown, a gorge has been cut seventy-three feet in depth.

It is in these places that the rock loving ferns find congenial habitat. There are rich wet woods—remnants of noble forests—where the sylvan groups are well represented; while swamps of greater or less area are scattered over the county where ferns of the marsh or bog flourish.

In its remarkably varied character in such small compass, Mill Creek Park represents the whole county so faithfully that the botanist may expect, and without disappointment, to find therein almost a complete living index to the fern flora of Mahoning County.

The ferns listed below have been verified by Prof. J. H. Schaffner and are represented by specimens deposited in the State Herbarium at Columbus, Ohio.

Polypodium vulgare L. Common Polypody. Commonest on rocks and ledges, its natural home, but also found on stumps and logs.

Phegopteris polypodioides Fée. Long Beech Fern. Appears to be well distributed growing on high banks and on sandstone ledges, not so abundant as the next species which is frequently found growing with it. Abundant in Mill Creek Park and along the Mahoning River in Berlin Township.

Phegopteris hexagonoptera (Mx.) Broad Beech Fern. Common everywhere in moist shady woods.

Adiantum pedatum L. Maiden-hair Fern. Everywhere and common.

Pteris aquilina L. Common Brake. Common. Wherever found there is a generous colony preempting the ground.

Asplenium pinnatifidum Nutt. Pinnatifid Spleenwort. July 18, 1909, while carefully searching the cliffs in Mill Creek Park near Lautermain Falls, the writer discovered this rare species. This is at once the most eastern and northern station for this

fern in the state. Originally but one block, the operation of man, first in building the now abandoned grist mill and more recently the high bridge across Mill Creek Gorge, has cut it up into three approximate stations containing in all a little over two hundred plants. The stream flows about east and west at this point and the ferns all grow on the north side. Forked fronds and those with pinnules elongated beyond the middle were found.

Asplenium trichomanes L. Maiden-hair Spleenwort. Found principally along ledges in Mill Creek Park, although it grows in similar locations along the Mahoning River.

Asplenium platyneuron (L.) Mill Creek Park, along the Mahoning and in wooded and rocky slopes.

Asplenium montanum Willd. Mountain Spleenwort. So far but one station and that quite restricted for this somewhat rare Ohio fern: "Standing Rock" in the Mahoning River in Berlin township. This curious boat-shaped sand-stone rock has been eroded free from a jutting "bogi back" through the united action of the river and a tributary, and stands a picturesque mass 15 to 20 ft. high, 82 ft. long, 27 wide at base and 7 to 12 ft. wide at top. And in the crannies of its fractured sides from 150 to 175 plants cling in flourishing condition.

Thus far diligent search has failed to extend the distribution either in the neighborhood of this rock or elsewhere in the county.

Asplenium angustifolium Mx. Narrow-leaved Spleenwort. So far its title to a place in this list rests on a single sterile plant growing in low moist woods in Ellsworth Township. During several years of watching it has failed to put forth a fertile frond.

Asplenium acrostichoides Sw. Silvery Spleenwort. Rather common in its distribution over the county.

Asplenium filix-foemina. Lady Fern. As common in distribution as in variation.

Camptosorus rhizophyllus (L.) Walking Fern. Abundant on rocky walls of Mill Creek Park. Grows in similar situations along the Mahoning.

Polystichum acrostichoides (Mx.) Christmas Fern. Found everywhere in the county.

Aspidium thelypteris (L.) Marsh Fern. One of the commonest ferns, found in marshy places, wet pastures, woods, etc.

Aspidium noveboracense (L.) New York Fern. As delicate in design as in its exquisite shade of green. In damp woods, wet pastures, shaded ravines or on wooded banks, in which two latter places it attains highest perfection. Often found growing with the last mentioned and is abundant in the county.

Aspidium cristatum L. Crested Fern. Of general distribution though it does not form dense clumps or banks like some other ferns and so does not appear so abundant.

Aspidium marginale (L.) Marginal shield Fern. Common on ledges or on steep wooded hill sides and even low wet wood lands.

Aspidium spinulosum intermedium. Muhl. Common in woods as well as in the deep ravines and on wet rocks of Mill Creek Park and similar situations along the Mahoning. Annoyingly various but nothing approaching specific types has yet been found.

Cystopteris fagilis (L). Fragile Bladder Fern. As common in all situations as it is various in form. In low woods as well as on cliffs and rocks.

Dicksonia punctilobula (Mx.) Hayscented Fern, Boulder Fern. This graceful delicate green fern may be considered quite common in this county, attaining perfection in rich shady woods as well as on wet shaded rocks and cliffs, in which last location like the Bladder Fern its fronds become much elongated and elegantly tapered.

Onoclea sensibilis L. Sensitive Fern. Common in woods, thickets and pastures everywhere. Some seasons there appears a riot of that sportive so-called variety obtusilobata appearing to illustrate the evolution or intermarriage of sterile and fertile fronds. When they abound one season you search for them the following year in vain.

Osmunda regalis L. Flowering Fern. Found to some extent in wet woods and swamps.

Osmunda cinnamomea L. Cinnamon Fern. In swamps and wet pastures, though not common as in the tamarack bogs of some places in this corner of the state; a bog of this kind in Boardman Township having been destroyed.

Osmunda claytoniana L. Not abundant, though it may be found generally distributed.

Ophioglossum vulgatum (L). Adder's Tongue. For this plant the writer has two stations in the county viz: Jackson Township, June 9, 1900, where it has not been rediscovered, and Ellsworth Township, June 13, 1909. This plant being so readily overlooked is doubtless more common than would seem.

Botrychium obliquum Muhl. Grape Fern and var. dissectum. Their common form grows everywhere in woods and pasture and spring together as if from a common root.

Botrychium virginianum (L). More abundant than the last. The size attained depending upon the moist richness of the woods where heavy shade is a factor.

With the exception of Asplenium angustifolium, Asplenium montanum, and Ophioglossum vulgatum, I have found all of the above in Mill Creek Park, and probably two of the three will yet be found there.

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PENNSYLVANIAN LIMESTONES OF NORTHEASTERN OHIO BELOW THE LOWER KITTANNING COAL.

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INTRODUCTION

In the Lower Coal measures of Pennsylvania and Ohio there occur certain beds of Limestone whose outcrop is known to be more or less continuous around the northern, the northwestern, and the western border of the Appalachian coal basin. This is true more particularly of those limestones occurring below the horizon of the Lower Kittanning coal. This coal with its companion, the famous Middle Kittanning coal, constitutes a band which, for extent, continuity, importance, and distinctness, is perhaps second to none in the belt of the Lower Coal measures. This band divides the Lower Coal Measure limestones into two groups—those below the Kittanning Coals and those above them.

The purpose of this paper is a discussion of the Limestones below these well known coals. Accordingly for definiteness and convenience of reference the line is drawn at the base of the Lower Kittanning coal.

REVIEW OF LITERATURE.

For our present knowledge of these limestones as they occur in the State of Pennsylvania, we are indebted chiefly to H. D. Rogers, H. Martyn Chance, I. C. White, and F. G. Clapp. Rogers in 1858 in his general section of the bituminous coal field of Pennsylvania (the section beginning in Mercer and ending in Greene County) gives only two limestones below the Lower Kittanning Coal. The lower one of 2 feet thickness he names the Mercer Limestone. [Geol. Penn. Vol. II, Part I, p. 476.] On the next page of the same report he gives another limestone—Mahoning Limestone—as forming the top of the Tionesta Group. On another page he states as follows:

"* * * * in the neighborhood of New Castle on the Beaver River, another limestone bed, the Mahoning Limestone, 2 feet thick, is interposed immediately under the Tionesta sandstone;" [Geol. Penn. Vol. II, Part I p. 489.]

Of the Ferriferous Limestone, which is the first one below the Lower Kittanning Coal, he states that it is so called because in many localities a valuable deposit of iron ore rests directly upon it. At New Castle he says this limestone rests upon the "Scrubgrass Coal-bed," the latter having a maximum thickness of 20 inches. (Geol. Penn. Vol. II, Part I, p. 491.]

In 1875 in his report on Beaver Valley, H. Martyn Chance states as follows:

"Both of the Mercer limestones were seldom seen in one locality one or the other generally being absent, and it is often difficult to tell to which of the two the one noted should be referred—the upper Mercer Limestone usually occurring at 90 to 115 feet beneath that stratum." (Ferriferous limestone.) [Sec. Geol. Sur. Pa. Vol. V. p. 189.]

In his report on Mercer County in 1878 under the head of *The Upper Mercer Limestone*, I. C. White writes as follows concerning that stratum:

"This is the 'Mahoning Limestone of Rogers' who recognized it on the Mahoning River, but not in Mercer County, where in fact it can only be seen at a few localities." [Sec. Geol. Sur. Pa., Rep. Prog. 1878 Q. Q. Q. Geol. Mercer County, p. 36.]

The same writer further says that in the southeast part of Shenango Township (the southwestern township of Mercer County and adjacent to Ohio), the *Mercer Lower Limestone* is here seen in two layers (a character which it often exhibits), the upper one 2 feet thick and the lower one 6 inches. There does not appear to be any separating material, not even the thinnest shale, but the layers appear to be in immediate contact, and both are richly fossiliferous; species of *Spirifer. Productus*, and *Crinoids* being especially numerous. [Geol. Sur. Q. Q. Q. p. 97.]

Discussing the ferriferous limestone in his report on Butler County, Chance makes this statement of it:

"In Ohio, except at Lowellville, on the Mahoning, where it exhibits its usual character, it is much thinner than in Pennsylvania, and, compared to its value in the latter state, is worth but little, either as a limestone or as an iron ore carrier. Its outcrop enters Ohio near the Mahoning river." [Geol. Sur. Pa. Report of Progress V, p. 142. 1878.]

In a bulletin prepared by F. G. Clapp and issued by the U. S. Geol. Sur. in 1904 on the "Limestones of Southwestern Pennsylvania," the ferriferous limestone is somewhat fully treated in an economic way. He renamed it the *Vanport Limestone* from typical outcrops at Vanport on the Ohio River in Beaver County,

Pennsylvania. [U. S. Geol. Sur. Bul. 249, p. 37.] This is clearly a better name than Ferriferous and it will doubtless prevail. He has mapped its outcrop in that state and shows it present up the Ohio, the Beaver, and the Mahoning Rivers, and that it is the thick limestone found in the hill tops at Bessemer, Hillsville and entering Ohio at Lowellville.

It is apparent from this brief review of Pennsylvania geology bearing on this lower group of limestone in that part of Pennsylvania adjacent to Ohio, that there are but three limestone so far observed. They are the Lower Mercer, Upper Mercer, and Vanport Limestones, the first two being named from outcrops near Mercer, Mercer County, Pennsylvania.

In Ohio we are indebted very largely to E. B. Andrews, J. S. Newberry, and Edward Orton for our present knowledge of the occurrence, the character, and the strata associated with the limestones considered in this paper. So often have they described and spoken of them in the Reports of the Ohio Geological Survey that indeed the names of these limestones—Lower Mercer, Upper Mercer, Putnam Hill, and Ferriferous, are quite familiar to every one at all conversant with Ohio geology. The first two and last of these names are of Pennsylvania origin as already noted. The third, or Putnam Hill, is a name of Ohio origin and was given by Andrews in 1869 to a conspicuous stratum of limestone typically exposed in the above hill at the foot of which nestles the city of Zanesville. [Ohio Geol. Sur. Rep. of Prog. 1869.] When Andrews named this stratum the other names did not exist in Ohio nomenclature, as it appears only one of the other three limestones was noticed. That stratum has since been considered the Lower Mercer and seen in the river bed at Zanesville. It does not appear, so far as the writer is aware, that these limestones observed at Zanesville were at first even suspected of being the same strata found beyond the Pennsylvania line. Later however these strata were traced northward through Muskingum, Coshocton, Tuscarawas, and Stark Counties, and the Putnam Hill found to be the principal limestone stratum but apparently disappearing from the section north eastward from central Stark County. The *Lower* or *Blue Limestone*, as it is usually called, was named the *Zoar Limestone* 1878 by Newberry from the typical exposures near Zoar in Tuscarawas County. [Ohio Geol. Sur. Vol. III, p. 60.] But this stratum was later regarded as identical with the Lower Mercer in Pennsylvania and the latter having priority the name Zoar is discontinued.

In his discussion of Coal No. 4 under the head of "The Carboniferous System of Ohio," Newberry in 1874 states that:

"Throughout the greater part of the belt of outcrop of the Lower Coal Measures in Ohio, at a distance varying from 20 to

90 feet above Coal No. 3 another coal, another limestone, and another ore bed are found. * * * * * * Where the interval between the limestones is considerable, two and sometimes three coal seams are found between them." (Ohio Geol. Sur. Vol. II, p. 139.]

The writer questions the interval of 20 feet between the Lower or Blue Limestone (which is probably the Lower Mercer) and the Putnam Hill. There are other limestones between these two which Newberry so far has not reckoned with and it seems quite probable that where an interval of much less than 90 feet occurs another stratum is met.

In his report on Stark County [Ohio Geol. Sur. Vol. III, pp. 151–176] Newberry nowhere mentions the presence of more than two limestones below the Lower Kittanning Coal. He regularly regards the upper one of the two given as the Putnam Hill, and the lower one, the Lower or Blue Limestone. There is evidently mistaken identification as will appear later in the detail study to follow.

One county remains to be considered which will complete a belt of territory extending from Muskingum County, Ohio, to southwestern Mercer County, Pennsylvania, in which belt the lower group of limestones occurs. The last link is Mahoning County. In his report on this county Newberry notes the presence of four limestones below the Lower Kittanning Coal as indicated in the "Section at Lowell" [Ohio Geol. Sur. Vol. III, opposite p. 804.] Near Youngstown three limestones are indicated as present [Ohio Geol. Sur. Vol. III, p. 803]. The upper one of these is certainly a new stratum and not in the "Section at Lowell" as will be shown later. On Indian Creek in Canfield Township he notes the presence of two limestones and designates the associated coals as "No. 3 and 3a," which would indicate that he regarded the lower limestone as the Lower or Blue Limestone. This identification will be considered later.

In his report on Coshocton County, Read notes a limestone between the "Blue" or "Zoar," and the "Gray" or "Putnam Hill," and near the former. [Ohio Geol. Sur. Vol. III, p. 567.] Andrews appears to have observed another limestone near the Zoar or Lower Mercer in northern Muskingum County. He also notes a thin limestone above the Putnam Hill at Zanesville. [Ohio Geol. Sur. Vol. III, p. 823.] Orton also notes a limestone 30 to 40 feet above the Zoar in Vinton and Hocking counties, which he names the "Gore Limestone" in 1878, apparently from a village in north-eastern Hocking County. [Ohio Geol. Sur. Vol. III, p. 898.] Thus in 1878 a limestone occuring between the Lower Mercer and the Putnam Hill was recognized in rather widely separated places.

In 1884 Dr. Orton in a discussion of the "Stratigraphical Order" gives the fullest account of the Lower Coal Measure Limestones yet to appear. He here correlates the Gore Limestone with the Upper Mercer of Pennsylvania and regards the limestone found between the Lower Mercer and Putnam Hill in the different counties as identical with the Upper Mercer. He states that:

"It everywhere lacks the remarkable steadiness and continuity of the Lower Mercer, but in all other respects it is almost the exact counterpart of that well-marked stratum. It has, in the main, the same chemical composition, the same color, and other physical properties, and also the same fossils. In many instances the limestones can be distinguished only by their stratigraphical order." [Ohio Geol. Sur. Vol. V, p. 15.]

In discussing the Ferriferous Limestone, Dr. Orton says of it,

"* * * * there are still unsettled questions as to its westward extension through a number of counties."

"From the eastern side of Mahoning County, to the center of Perry County, the Ferriferous Limestone is either feebly developed and obscure or is altogether wanting. But in this very interval where the Ferriferous Limestone has grown weak and uncertain, another limestone of the same general character is found, which completely bridges the chasm and by means of which we are able to maintain the unity of the series unbroken. This is the Gray limestone of Newberry and the original Putnam Hill of Andrews."

"* * * * The Putnam Hill limestone underlies the Ferriferous by 15 to 50 feet. The usual interval may be counted 30 feet.

"* * * * The Putnam Hill limestone is from 25 to 50 feet above the Upper Mercer Limestone * * * *." [Ohio Geol. Sur. Vol. V, pp. 19–21.]

In a report in 1906 dealing with the limestones of Ohio, Edward Orton, Jr., and S. V. Peppel review these Coal Measure Limestones and make the following statement regarding the Putnam Hill:

"It is very close, stratigraphically, to the Ferriferous Limestone, a very important bed. The area occupied by the two does not overlap, so far as the knowlegde of the writers extends. At the point where the Ferriferous is present, the Putnam Hill is not likely to be found, and vice versa. Both stones lie close below the Lower Kittanning or No. 5 coal, but they are probably stratigraphically distinct." [Ohio Geol. Sur. Vol. IX, Bull. 4, p. 173.]

Of the Ferriferous Limestone, the same writers state that:

"In stratigraphical position, the Ferriferous belongs a short distance above the Putnam Hill Limestone and from twenty to forty feet below the Lower Kittanning coal. This places it near the bottom of the Allegheny formation.

"* * * * Toward the southwest (from Lowellville) the formation becomes more and more sparing in its exposures, and thinner, until in southwestern Stark County and northeastern Tuscarawas County it disappears, and the Putnam Hill Limestone comes in on nearly the same horizon, but stratigraphically distinct." [Ohio Geol. Sur. Vol. IX, Bull. 4, p. 174.]

From this brief review of the literature on these limestones it is quite apparent that three limestones are recognized in Western Pennsylvania below the Lower Kittanning Coal, and in Ohio four are recognized below the same horizon. In the former state the Lower Mercer and Vanport are the more important stratigraphical horizons; in the latter state the Lower Mercer and the Putnam Hill have that distinction. It is also apparent that uncertainty characterizes the present knowledge of the presence and character of the westward extension of the Vanport limestone from eastern Mahoning County, and likewise the eastward extension of the Putnam Hill from Central Stark County. The Lower Mercer is regarded as the unfailing limestone from Mercer County, Pennsylvania, to Zanesville, and as the lowest and earliest limestone in the Lower Coal Measures. The Upper Mercer is conceded to be present in many places, but by no means so regularly present as the Lower Mercer.

SURFACE, STREAMS, AND ELEVATIONS.

From central and southern Stark County southwestward, it would appear from the Ohio Reports that these limestones are fairly well known and the same can be said of them on the eastern line of the state. But from central Stark County to the Pennsylvania line they are not well known. Consequently a somewhat careful examination has been made of this territory covering an extent of about fifty miles. Of the region examined all but a little in southern Stark County is deeply drift covered, and only now and then can the strata be seen to emerge from the drift mantle save along streams and even here long intervals often occur between meager outcrops.

From west to east the following streams and tributaries have been examined for outcrops of the above limestones: Nimishillen Creek, Mahoning River, Island Creek, Little Mill Creek, Turkey Broth, Meander Creek, McMahon Run, Diehl Creek, Mill Creek, Neff Run, Indian Creek, Yellow Creek, Burgess Run, and Furnace Run, all of which are shown on the accompanying map of Stark and Mahoning Counties.

Elevation will be seen to be an exceedingly important factor in obtaining the results of this investigation and it is constantly employed in determinations. The elevations given were obtained by level from elevations indicated in the field by the

United States Geological Survey, from railroad elevations, and in a few cases from topographical maps. In every case the elevation given below will be understood to mean the *elevation of the top of the stratum named*, and intervals between strata will be understood to mean *between their tops* unless otherwise explained.

Other strata associated with the limestones receive attention only in so far as they add interest to the setting and identity of the limestones in different places, or when well-known horizons are exhibited and call for brief recognition.

DESCRIPTION OF SECTIONS.

Nimishillen Valley.

Howenstein. In the valley of the Nimishillen about six miles south of Canton and about four miles north from the county line good outcrops of limestones are found near the village of Howenstein. A rather long section is afforded here since the valley is narrow and deep and the hills rather high. Almost every foot of the strata may be seen from the Lower Mercer Limestone in the bed of the stream up to thirty feet or more above the Middle Kittanning Coal. At Howenstein a limestone is found in the creek bed but cannot be seen well here. At Mr. John Shew's Mill a half mile below the village the limestone is still found in the stream bed.

A wall under the mill is constructed of this stratum lifted from the stream bed and the thickness is seen to be 10 to 12 inches. It is reported by Mr. Shew to be one foot or a little over and lifts in two layers. It is underlain by a thin coal and is dark gray in color weathering to a yellowish gray. Segments of crinoid stems and brachiopods constitute the fossils seen. The limestone can be seen some distance below the mill in the creek bed.

Above the railroad on the west side of the stream occurs a second limestone which is undoubtedly the Upper Mercer as will appear from sections to follow. This point is about 300 yards below the mill, and the interval from top to top where measured is 28 feet which is greater than the usual interval between these limestones. The interval is usually 20 to 25 feet. At this outcrop the Upper Mercer is 14 inches thick and in one layer. In other characters it is practically like the lower limestone. Four hundred yards above the mill and on the west side of the railroad this stratum is seen to be 21 inches thick and resting upon 18 inches of coal. It is also seen to rise and fall, or undulate and is certainly considerably less than 28 feet above the lower limestone, probably less than 20 feet in places. It can be seen at a number of points along the railroad up to Howenstein where it is seen at several points on the east side of the creek in the bank above

the dugway. At the south end of the dugway, or highway cut, it appears at the same level as where last seen on the west side near the railroad switch below Howenstein a few hundred yards.

It may be noted in passing that the Upper Mercer coal thickens here to about 3 feet and a mine has been opened in it a quarter of a mile below Howenstein.

The overlying limestone is also removed. This is the only mine met with in the territory covered opened in this coal; it nowhere else was found reaching this thickness.

Near the north end of the highway cut the Upper Mercer limestone is well exposed beside the roadway. It occurs in two layers, the lower layer being very tough, bluish gray and 23 inches thick. The upper layer is brownish, coarser grained, contains considerable iron ore, and is 10 inches thick. The two layers thicken and thin at the expense of each other. No coal is found under it.

At this outcrop a ravine trenches the hillside, and in this ravine two or three rods above the roadway another stratum of limestone is found at 22 feet 7 inches above the Upper Mercer limestone, and 15 inches thick. It is blue-black, very tough, and in one layer. It can be seen all along the bank above the roadway, but concretionary rather than as a continuous stratum. Coaly shale and fire clay underlie it. Northeast of the creek bridge at Howenstein about 200 yards and beside the hill road it may be seen in the run bed for several rods where it occurs in a definite bed showing decided undulation. This stratum is not the Putnam Hill limestone as might be thought. It is too near the Upper Mercer, and too far below the Lower Kittaning Coal, besides the Putnam Hill is present in the section at its proper horizon. It is clearly a new element not before recognized. Again, it is not merely a local development but is found nearly to the state-line as will appear in descriptions to follow.

Having to deal with it repeatedly the writer names it the *Howenstein limestone*. At the south end of the highway cut and near the bridge the Howenstein limestone lies at 991 feet above sea, and 21 feet above rail at Howenstein depot. From this elevation the Upper Mercer is seen to lie at about 967 above, and the Lower Mercer at about 939.

In the hill-side ravine spoken of above and sixty feet above the Howenstein limestone a fourth limestone occurs at 1051 feet above sea. This is undoubtedly the Putnam Hill which is here 2 feet, 8 inches thick and resting upon a bed of coal. Being only partially exposed the thickness was not obtained. Two miles up the Nimishillen this coal lies in two benches and is 4 feet thick capped by the same limestone. As seen in the above ravine this limestone is rather a dark gray, weathering to a gray or a yellow-gray. It is very tough and lies in one layer. Crinoid

stems and brachiopods were the only fossils noted. In general appearance it is not enough unlike the Mercer limestones to distinguish between them readily. But the Howenstein can be easily distinguished from either of the others by its much darker color.

A fourth of a mile east of this outcrop and on the hill-road a little above the point where it emerges from the woods, the horizon of the Putnam Hill is marked in the roadway by fireclay and coal blossom which lies 64 feet above the Howenstein limestone as seen below beside the hill road. A few hundred yards further to the east and to the right of the road and on the farm of Mr. John Shertzer the Lower Kittanning coal is well exposed in a clay pit at 1125 feet above sea.

It is three feet thick and is underlain by about 20 feet of fireclay. The top of this coal lies about 73 feet above the Putnam Hill limestone. 39 feet below the top of this coal a bed of fireclay occurs which marks the horizon of the Vanport limestone at 1086 feet above the sea. The limestone does not appear at this point but about four hundred yards north of the Shertzer barn in a ravine in the edge of the woods the limestone was found and at 39 feet below the top of the above coal. The limestone as found here does not exceed 8 inches thickness, is of a dark gray color, weathers to a rusty-brown, and is sparingly fossiliferous.

It may be noted here that the Middle Kittanning coal is 3 feet, to 3 feet 8 inches thick and lies at 1160 above sea.

North Industry. At the head of the gorge of the Nimishillen and about 3½ miles below Canton is the village of North Industry. Outcrops of limestone are numerous in this vicinity and all five are again found with ease especially the four lower ones. The top of the rail at the depot lies at 998 feet above sea, and directly above the station in the old shale quarry the Putnam Hill may be seen at 59 feet above rail or 1057 feet above sea. Here as elsewhere in the valley of the Nimishillen it is an unmistakable horizon. It is 4 feet thick in places and possesses practically the same characters as in the preceding section. 2 inches of shale separate it from the 18 inch coal underlying it. The Howenstein limestone is due at about the level of the depot but is not seen there. A short distance below the station along the tracks it is imperfectly exposed. Opposite the station and near water level in the creek, occurs the lowest limestone visible in this immediate locality. It lies 78 feet below the Putnam Hill at the highest point observed, or at 979 above sea. It will exceed the interval of 78 feet, however, by several feet as it is observed to sink beneath the stream. This is undoubtedly the Upper Mercer or the second limestone noted at *Howenstein*. As seen here it is 21 inches thick, in three layers and much ironstained, the upper layer of 3 inches thickness being heavily charged with iron ore. Sandy shale underlies it.

A typical section for this region may be found about $\frac{3}{4}$ of a mile below. Beside the residence of Amanda Stallman a deep ravine exposes the four lower limestones. Well up the hillside the Putnam Hill is found with a thickness of $3\frac{1}{2}$ feet resting upon coal partially exposed. Forty-four feet below its top occurs the Howenstein 1 foot, 9 inches thick tougher and much bluer than the Putnam Hill. Twenty-one feet, 6 inches below the top of the Howenstein lies the Upper Mercer in the run bed beside the Stallman residence. It appears to be double here. The upper half is 2 feet, 9 inches in thickness, lies 2 feet above the lower half, is bluish in color, quite tough and in several layers. The character of the two feet between the halves was not seen. The lower half is two feet eight inches thick and in three layers. The bottom of the lower half lies 6 feet above water in the Nimishillen. About 4 feet below water surface lies the Lower Mercer in the creek bed. It is clear therefore that the two divisions just given is not a close approach of the two Mercer limestones but a split of one of them. Nowhere else was this character found, but it is suggested in the expression of the two layers as noted at Howenstein. It is possible that the limestone seen near creek level opposite the North Industry depot is this upper half of the Upper Mercer. The Lower Mercer in the creek bed is said to be about 1 foot thick and lies $17\frac{1}{2}$ feet below the top of the Upper Mercer. A little below, this limestone is seen at the ripple near the highway bridge.

A short distance below the Stallman ravine and on the opposite side a deep ravine joins the gorge at the mouth of which is the tipple of The Nimishillen Coal Company. The mine is a few hundred yards up the ravine and is opened in the coal beneath the Putnam Hill limestone. The coal lies in two benches two feet each with a conspicuous 3 inch shale parting as seen at the lower opening. The limestone is massive, tough, and having a bluish tint where freshly quarried. Two layers are presented here, the lower one 1 foot, 2 inches, and the upper one 2 feet, 8 inches in thickness. Crinoid stems and brachiopods comprise the fossils observed. The company has been quarrying the limestone recently and crushing it for macadamizing. At the upper opening the limestone and coal present the same characters except the lower bench of coal has thickened to two feet nine inches.

The section begun in the Stallman ravine may be completed here. At the point where the Putnam Hill becomes the ravine floor and on the left hand the steep slope presents every foot of the strata up to a point considerably above the horizon of the Vanport limestone. No definite bed distinctly limestone is found here. But at 37 feet above the Putnam Hill irregular concretion-

ary masses of 3 to 8 inches thickness and much iron stained respond promptly to acid. These are imbedded in the dark gray sandy shale and would never be noticed were one not looking sharply for the vestiges of limestone.

Canton. From North Industry up the valley the Putnam Hill is exposed at different places, but the next good exposure occurs at the Imperial Brick Plant in southwest Canton where the shale above and the fireclay beneath this limestone are used in brickmaking. Here the Putnam Hill is 2 feet, 9 inches thick and underlain by 18 inches of coal.

As nearly as can be determined from a topographic map its elevation is 1075 feet above sea. The hill is high enough to carry the Vanport but it was not seen, arenaceous shale occupying its horizon.

The brick plant is located on the roadway leading to Navarre and just above the bridge crossing a small creek near the brick plant the Howenstein limestone is exposed in the creek bank 5 feet above the stream level. It lies 50 feet below the top of the Putnam Hill or at 1025, is bluer than the upper limestone, and is 1 foot thick. One to four inches of yellow clay and 4 inches of coal beneath the clay directly underlie the limestone.

In his report on Stark County Dr. Newberry constantly refers to the limestone below the Putnam Hill as the "lower limestone" and in reference to certain borings in the vicinity of Canton states that they were begun at about the horizon of the "lower limestone" which he reports is visible in places. These borings appear to have been in the vicinity of the above outcrops of limestone, and it seems quite certain that his "lower limestone" is the Howenstein. In the well section given it is 1 foot, 2 inches thick. [Ohio Geol. Sur. Vol. III, p. 159.] This is quite in accord with the Howenstein as seen near the brick plant. Another stratum of interest, however, appears in the above well section. Twenty-two feet below the top of the above 14 inch limestone is recorded a "Hard Blue Rock" 2 feet and 1 inch thick. The driller does not seem to have known just what to call it, and Dr. Newberry does not seem to have suspected it of being another limestone, which it certainly is. At Howenstein the same interval is 22 feet 7 inches, in the Stallman ravine 21 feet, 6 inches. From these facts the identity of these limestones as found in southwest Canton appears to be unquestionable. The "lower limestone" of Newberry, therefore, is the Howenstein, the "Hard Blue Rock" is the Upper Mercer, and the Lower Mercer absent being replaced by shale and sandstone.

In northwest Canton in the sides of a ravine which enters the West Lawn Cemetery from the west, limestone occurs at about 1090 feet above sea, as nearly as could be determined

from topographic map. It was formerly quarried and burned beside the roadway on the west side of the Cemetery. The owner of the land reports the limestone as 4 feet thick and underlaid by about 2 feet of coal. This stratum is clearly the Putnam Hill limestone.

Middle Branch. In the vicinity of Middle Branch a village about 7 miles north of Canton several outcrops of limestone occur. In fact almost anywhere at the proper horizon where the native strata occur limestone is present. It is often absent but this is due to preglacial erosion and drift now occupies its position in such places. The most extensive exposure of this conspicuous stratum occurs at the quarry of the Diamond Cement Works about a mile north of Middle Branch. This point is nearly 8 miles from the outcrop in northwest Canton, but various outcrops from Canton northward show this heavy stratum with its underlying coal to be the Putnam Hill limestone. The 11-inch coal as seen in the quarry is heavily charged with sulphur which is typical of it south of Canton. Furthermore a limestone is found above the quarry stratum near the quarry, and the elevation of the limestones here indicates a gradual rise which is quite in harmony with facts found from Howenstein to Canton. It appears quite clear from all the data given that the limestones here to be described are the Putnam Hill and the Vanport. At this quarry acres of the Putnam Hill have been removed for the manufacture of cement and the best opportunity for studying this stratum found anywhere is presented here. It attains a greater thickness here than it is known to have in any other outcrop of its whole extent. The stratum as seen at the present time in the quarry is mostly overlain by drift and shows much scoring by the ice where the top is exposed especially on the north side of the quarry. In the center of the quarry a large block of the limestone has been left stand temporarily in order that the overlying shale may be used in the manufacture of cement. Practically everywhere else the ice seems to have swept the limestone bare but here in the center 16½ feet of brown arenceous shale caps the stratum. The quarry is being extended northward toward the hill and the same shale will doubtless be encountered in a few years. A very striking feature of the limestone is the pronounced undulation found. This is a character, however, common to all the limestones but no other outcrop affords so good an opportunity of seeing it in the Putnam Hill. It is quite evident that such undulation will affect the measurements of sections, especially where the wave crest of one limestone occurs above the trough of another, thus making the strata appear farther apart than they really are, or again if the section be measured where a crest of the lower, and a trough of the upper occur they will

appear to be closer than they really are. Ordinarily it is not possible in a limited outcrop to determine whether undulation exists or not. Therefore in sections where limestones are shown to be unusually close together or unusually far apart it is only fair to suppose that undulation is probably the cause provided the difference be not over 15 to 17 feet as no undulation observed exceeds that measurement.

In the above quarry the rise and fall was not observed to exceed 6 or 7 feet and no definite order was discovered as the rising and falling occurs, no matter in what direction the observation be made. The limestone merely conforms to the topography of the sea bottom on which it was laid as a mud without becoming thicker in the depressions and thinner on the elevations of that bottom. Had the mud or ooze been considerably greater in specific gravity than the water in which it was laid it would doubtless have glided slowly into the depressions where the greater slopes occur and thus cause the upper and lower surfaces to be less parallel than we find them.

As nearly as could be determined from a topographic map the top of the Vanport lies at 1180 above sea as seen in the hill-top directly north of the quarry and the Putnam Hill lies 37 feet below, or 1143 above sea as measured in the northeast corner of the quarry.

The following section measured near the center of the quarry represents the character of this limestone fairly accurately.

		Feet	Inches
	Brown arenaceous shale	16	6
8.	Limestone layer	1	7
7.	Parting, calcareous shale	0	2
6.	Limestone layer	1	4
5.	Limestone layer	0	7
4.	Limestone layer	1	11
3.	Limestone layer	1	8
2.	Parting, thin shale	0	0
1.	Limestone layer	0	11
	Coal	0	11

No. 8, or the top layer of limestone, is perhaps the most distinct layer in the quarry and is readily recognized in any part of the quarry where it has not been cut away by the ice. The shale parting beneath gives it the well marked separation from the next layer. On weathering it tends to split up into numerous thin layers and does not appear to be as pure a lime as the lower layers.

No. 7 is a conspicuous parting of bluish calcareous shale of 2 inches thickness. It is the most sharply defined and constant plane of separation in the quarry.

No. 6 is dark gray in color, is not so compact as 4 and 5 below it, and has more jointing planes than these layers. It rests immediately upon No. 5 from which it is separated by an uneven bedding plane and has a thickness of 16 inches.

Nos. 5 and 4 having a thickness of 7 inches and 23 inches respectively, are brown-gray in color, quite compact, weather less easily than the upper layers, and are said to be the best stone in the quarry. These layers are separated by a peculiar wavy bedding plane the elevations of which measure 1 to 1½ inches and 3 to 5 inches between as seen on the rock face.

No. 3 measures 20 inches, is of a gray color slightly darker than the layer below it and also purer lime than that layer but not so good as those next above it. It is more compact than the lower layer.

No. 2 is a thin calcareous shale parting of negligible thickness and of the color of the stone.

No. 1 has a thickness of 11 inches, is gray in color and is said to weather to a shale condition after a few months exposure. It is not as tough as the middle layers and rests upon the coal.

In the south wall of the quarry the limestone presents five layers below the conspicuous shale parting but of nearer equal thickness than shown in the above section.

The outcrop of the Vanport noted above occurs in the hill-top just above the township road in a private roadway about 30 yards north of Mr. Adam Cocklin's barn and about 200 yards north of the quarry. This stratum is poorly exposed and as nearly as could be determined it is 6 feet, 5 inches thick, caps the hill and is thinly covered with drift. It may be seen again in the township road ¼ mile east of this outcrop and near the residence of Mr. Adam Wise, where it again caps the hill. Mr. Wise reports the presence of a thin coal beneath it.

Little more can be said of this limestone from the poor outcrops afforded. It is bluish gray in color and less fossiliferous than its companion so far as could be seen.

It probably occurs in all the surrounding hills whose strata are high enough to carry it but with its outcrop obscured by drift.

Its occurrence here in rather heavy body and above the Putnam Hill, which at this point exhibits the greatest development it is known to possess, is somewhat in contrast with the supposition that the two limestones do not overlap and that as the one appears the other disappears.

One mile south of the Middle Branch on the farm of William Worstler a quarry was operated on a small scale for many years and the stone burned for lime with the underlying coal. The following section indicates the character of the stratum in this quarry.

Drift	Feet	Inches
9. Calcareous shale	1	0
8. Clay parting	0	1½
7. Limestone layer	0	2
6. Limestone layer	0	2
5. Limestone layer	0	3
4. Limestone layer	0	4½
3. Limestone layer, massive	2	6
2. Limestone layer	0	11
1. Limestone layer, thickness not seen but probably about	1	0

The calcareous shale at the top lies in numerous definite layers and contains considerable alumina. It lifts readily in thin layers at the thin clayey partings. The clay parting between this shale and the limestone proper leads one to identify it at once with the 2 inch parting in the quarry at the cement works. The worthless shale here above the clay parting becomes an impure limestone at the cement works. The limestone has a light blue color and the coal beneath is said to be 14 inches thick. The Limestone lies at about 1120 feet above sea and is undoubtedly the Putnam Hill.

Mr. D. L. Worstler in 1907 opened a quarry to burn lime on the farm of B. F. Werner 1 mile southwest of Middle Branch and 1 mile northwest from the Worstler quarry. The elevation is about 1130 above sea. No shale layer or clay parting occurs here as drift lies directly upon firm rock. The following section indicates the nature of the stratum in this quarry.

Drift	Feet	Inches
5. Limestone, bluish gray	2	8
4. Limestone, bluish gray	1	4
3. Limsetone, black	1	2
2. Shale, bluish black	0	3
1. Coal	2	4

The upper part of the stratum of limestone has doubtless been eroded as the top layer shows abrasion. No. 4 is more compact than No. 5 which is in accord with the middle layers at the Cement Plant.

No. 3 is black and porous, and not so compact as No. 4. The pores are filled with oil which soon greases a freshly broken face and yields the characteristic odor. The coal is ample for burning the lime and runs from 24 to 28 inches in thickness. At a farm house about 350 yards west of this pit a limestone was penetrated in a well at about 35 or 40 feet above the quarry stone. These limestones are clearly those at the Cement Works.

Dip of the Strata in the Nimishillen Valley.

It readily appears from the elevations of the limestones at the various outcrops that there is a dip of the strata toward the south. Placing the elevations together of any one stratum from

south to north a gradual rise is observed. The Putnam Hill affords the best example being found at more points than any of the others.

It lies at Howenstein at 1051, North Industry 1057, southwest Canton 1075, northwest Canton 1090, Worstler quarry 1120, Werner quarry 1130, and at the Cement Plant at 1143. There is a fall therefore of 92 feet in this stratum from the latter place to Howenstein a distance of about 13 miles, or 7 feet per mile. The same is true of the Vanport which at Howenstein lies at 1086, at Cement Plant at 1180, and a fall of 94 feet or of 7 feet per mile.

This is not the direction of the greatest dip, however, as will be seen later.

EASTERN STARK COUNTY.

Alliance. But few limestone outcrops have been found in the eastern part of the county. The region is deeply drift covered and the strata are concealed for the most part. Two outcrops and two well sections afford the only information at hand on these limestones in that part of the county, and of these the well sections and one outcrop occur at Alliance. This city lies 10 miles east of the Cement Works mentioned above and the strata lie considerably lower at the former place than the latter. The Middle Kittanning coal lies at 1132 feet above sea in the coal shaft near the city Stand Pipe. In a test well drilled by the city on West State Street it lies at 1040, and at the Ely shaft ½ mile southwest of the Transue-Williams Machine Shops it lies at 1137 above sea. The Lower Kittanning coal was formerly mined near the above shops at 1100 above sea as nearly as could be determined. A half mile north of the above shops and the same distance west of the Alliance Cemetery a limestone outcrops on the Ellett farm at 1081 above sea. This is clearly the Vanport but it is closer to the Lower Kittanning coal than at Howenstein. The limestone is exposed in a pit near the Ellett barn and measures 5 feet in thickness. No coal but 4 feet of fireclay immediately underlies this stratum, and is overlain by 2 to 3 feet of drift. It differs from any other outcrop of limestone found in that it is composed of numerous irregular layers ranging from a fraction of an inch to 4 or 5 inches in thickness. It lifts in broad pieces of a very irregular form, sometimes wedge shaped. The stone is very impure, many of the slabs being a sandstone rather than a limestone and the parting between the slabs is clay or sandy shale. Some layers contain fairly pure limestone of a light blue color and quite compact. The stratum presents an alternation of irregular bands of light blue and brown, the shale and sandstone portions having the latter color. The stratum at this point seems to have been deposited in shallow water which was sometimes quiet and clear and sometimes flowing and muddy thus

giving the alternation of material noted. The stratum is quite fossiliferous containing brachipods, lamellibranchs, gastropods, and crinoid stems.

The next section to be considered is the test well drilled by the City just off West State.

The elevation of the well head is 1244 feet above the sea, and the Middle Kittanning coal was penetrated at 1140 and 2 feet thick. The Lower Kittanning is wanting and a 15-foot limestone is reported at its horizon the top of which lies at 1103 feet above sea. No limestone is known to the writer to occur at this horizon, and nothing further is known of the presence of such stratum than the bare name and thickness indicated in the City Engineer's section prepared from the data given by the driller. The driller's interpretation of this part of the section may be questioned with reason. It is much more likely a shale with possibly some calcareous matter in it. This horizon has been penetrated in many places in the lower part of the city as well as other drillings in the upper part of town not far from this well, and limestone is not mentioned at this horizon.

Where the level of the Vanport occurs white shale is indicated as present. At 1032 an 8 foot stratum was struck which the driller designated "Bastard Limestone." This is certainly the Putnam Hill Limestone with an interval of 49 feet between its top and that of the Vanport. The same interval at the Cement Plant is 37 feet and the difference is not too great to be accounted for by undulation, besides the Vanport is seen to lie unusually close to the Lower Kittanning coal. The interval at Howenstein between the top of the Putnam Hill limestone and that of the Middle Kittanning coal is 109 feet. In this well section it is 108 feet. It would seem that the identity of this limestone is evident. The thickness given is in harmony with that at the Cement Plant.

At 1008 feet above sea another limestone is recorded with a thickness of 9 feet. This is doubtless the Howenstein but with an indicated thickness greater than found in any outcrop. The interval is only about half that along the Nimishillen and apparently too great to be accounted for by undulation. It would seem to require a thinning of intervening strata.

In this well the horizon of the Mercer limestones is occupied by shale but in the next well to be noted they are both present, and for the sake of clearness, they are noted in this connection. The Upper Mercer lies at 966 above sea and reported to be 8 feet thick. This gives an interval of 42 feet between it and the Howenstein which is about as much greater than this same interval at Howenstein, as the interval here between the Putnam Hill and the Howenstein limestone is smaller than that same interval near

that village. At Howenstein the interval between the Putnam Hill and the Upper Mercer is 84 feet, at Alliance 66 feet and considering the fact that the Lower Mercer is present at its usual interval it would seem that this difference of 22 feet could hardly be regarded as due to undulation. It is possible however that both the Mercer limestones were penetrated on a crest which would account in part for the difference. Otherwise a thinning of intermediate strata is the explanation.

The Lower Mercer lies at 945 or 21 feet below the top of the Upper Mercer which is about its usual interval. It is recorded as 3 feet thick which accords quite well with its known thickness.

In the first well at an elevation of 884 feet above sea another limestone was penetrated having a thickness of 5 feet. This is clearly a stranger as it lies 61 feet below the Lower Mercer.

The second test well was drilled beside the city pumping station with the well head at 1044 above sea. The second well is nearly 2 miles north and ½ mile east of the first. This distance would seem at first to forbid the combination of measurements given above. But certain facts indicate that it may be done with a fair degree of certainty. (1) The Middle Kittanning coal in the Ely shaft lies at 1137 and in the first well at 1140. These points are nearly 1 mile apart and the shaft a little west of north. This would indicate that the plane of this coal in this direction is nearly level. Mr. Ely states that the coal rises a few feet from the shaft which further indicates horizontality. (2) In the second test well a 5-foot limestone was penetrated at 882 feet above sea, in the first well at 884 above. (3) Near Myers Station on the Lake Erie, Alliance and Wheeling Railroad, 11 miles south of the Ely Mine the Middle Kittanning coal lies at 1130 above sea, or a fall of 7 feet in 11 miles. From the first test well the fall is 10 feet in 10 miles.

These data indicate that the strata at Alliance lie very nearly on a level from north to south. Therefore the strata may be counted practically level so far as these two wells are concerned, and the combination made as given above.

Little more need be said of the second well. Sixty-eight feet of the top is drift and the bed rock is reached at 976 above sea, which is below the horizon of the Howenstein. The only other limestones to be expected are the Upper and Lower Mercer and these are present as noted above. The stranger is present also at 63 below the Lower Mercer as already stated. Sixty feet below the top of this limestone lies a 2 foot coal which is apparently the Sharon coal. It lies 37 feet lower than coal No. 1 in the Mullin Mine at Deerfield which would indicate that it is the same coal. This limestone will be considered further in another connection.

The second limestone outcrop in the eastern part of the county to be discussed occurs on the farm of Samuel Carr at a point

about 4 miles west of the exposure on the Ellet farm. This stratum is quarried and burned on a small scale by the Clapsaddle Brothers and is used by the Alliance City Disposal Plant which uses about 200 bushels of lime per week.

The quarry is opened beside a small run and nearly at run level. This stratum is 5 feet thick and lies at 1117 above sea. In places it is said to exceed this measurement and rests upon coal 5 to 18 inches in thickness. It is composed of several layers, is bluish gray in color and fairly fossiliferous. The upper third is somewhat lighter in color than the lower part, and the quarrymen state that this limestone produces a purer lime than the stone at Middle Branch.

No other limestone was found and the identity of this stratum would be difficult, if not impossible, to determine from what can be seen of it and the associated strata. In the absence of other data its identity may possibly be established in another way. Since the elevation of the Vanport at the Cement Plant is 1180, and 1081 on the Ellett farm, the strata are seen to dip toward Alliance 10 feet per mile. If this limestone in question be the Vanport then at 4 miles to the west of the Ellett farm it should lie at 1121 which is within 4 feet of the elevation actually found. If it be the Putnam Hill limestone whose elevation at the Cement Plant is 1143 and 1032 at Alliance having therefore, a dip of 11 feet per mile, at the Carr farm it should lie at 1076 which is 41 feet lower than the limestone is found to be. This would seem to identify it as certainly the Vanport. But the presence of a low fold between Alliance and Middle Branch would alter this conclusion. No evidence, however, of such a condition is known to the writer, hence he regards this as an outcrop of the Vanport.

Another section in the northeastern corner of the county is of interest in this connection. About 3 miles northeast of the Carr farm and on the diagonal road leading from Limaville to Marlboro at a point 2¼ miles southwest of Limaville is the shaft mine of Mr. Fred Lare. The elevation of the top of the shaft is about 1155 feet above sea.

Mr. Lare gives the following section:

4. Drift	42 feet.
3. White sandstone, hard and shaly	3 "
2. Shale, dark	15 "
1. Coal, bone parting near middle	4 "

This 4 foot coal which is said to be a good steam and heating coal lies at about 1095 above sea which is at once seen to be below the Carr limestone and with no trace of limestone in the shaft. The thickness and the parting in the middle strongly suggest the coal beneath the Putnam Hill limestone. This shaft, the Carr farm, and Howenstein are in line. The Vanport at Howenstein lies at 1086, on the Carr farm at 1117 and the two points are 16

miles apart. This shows a rise of 2 feet per mile, and if the Vanport were present in the shaft it would lie at about 1123 above sea. This puts the coal 28 feet below the Vanport horizon which is reasonably near the proper horizon for the coal beneath the Putnam Hill limestone. Furthermore no other coal between the Sharon and the Lower Kittanning is known to reach any such thickness or present a conspicuous parting in the middle. It may be confidently concluded that this is the coal of the Putnam Hill limestone with that stratum absent.

Deer Creek at Limaville lies at about 1040 above sea, low enough to expose one or two of the lower limestones but none were seen.

Dip of Strata in Eastern Stark County.

With the several elevations now at hand *dip* of the strata in the eastern half of Stark County may be still further noted. With the Vanport at 1086 at Howenstein, 1081 at Alliance, and 1180 at the Diamond Cement Plant, it appears that the strata lie almost horizontally from Howenstein to Alliance, but if the sum of the elevations of the five limestones at the two places be compared they will be seen to be 5034 and 5032 respectively which indicates almost a perfect level. A line drawn through the Cement Plant outcrop at right angles to the Alliance–Howenstein line gives the direction of maximum dip for this area. It is south about 45 degrees east and 14 feet per mile.

From the Cement Plant to the Ellett farm it is 10 miles with a fall of 99 feet and a little north of east. The Middle Kittanning coal at Howenstein lies at 1160; 12 miles slightly north of east near Myers Station it lies at 1130, or 30 feet fall. It is at once seen that these two lines of fall do not lie in the same plane, therefore a disturbance in the dip. In the absence of more data it can not be definitely stated what the cause is, but the writer offers the following tentative explanation. Entering Stark County from the southwest a low fold extends in a northeasterly direction the crest of which lies a little west of Canton and perhaps not far from Middle Branch. Parallel to this fold another is thought to extend through western Columbiana and central Mahoning counties. It is thought that Alliance lies near the bottom of the intervening trough or on the syncline, that Howenstein is situated west of the syncline and Myers Station east of it. The horizontal position of the strata at Alliance and the fact that there is less than 1 foot fall to the mile toward the south from that city inclines the writer to think that in going toward Myers Station the west slope of the anticline is gradually ascended and thus accounts for the slight dip in that direction. The line from Middle Branch to Howenstein is nearly parallel to the direction given above and it will be remembered that the dip here is 7

feet per mile and this is just what would be observed in traversing the slopes of anticlines in this way. Furthermore, an oil field is located 4 to 8 miles southeast of Alliance which strongly indicates the presence of an anticline. Other evidence of a fold to the east of Alliance will occur later.

SOUTHWESTERN MAHONING COUNTY.

Bests Station. This point is 4½ miles northeast of Alliance on the Lake Erie, Alliance and Wheeling Railroad, and, with the next two places to be mentioned, in line with Alliance and Howenstein. These three places—Bests Station, North Benton, and Little Mill Creek, furnish exposures that must be combined in a single section in order to be rightly understood and without resort to elevation it would be almost impossible to rightly interpret the several outcrops.

A fourth of a mile east of the station and near the right hand side of the roadway a limestone occurs which was formerly burned for lime. It is not now exposed to its base, but is about 3 feet in thickness, apparently in one massive layer, tough, and rather dark gray or almost black in color. It lies at 1101 feet above sea and is the Vanport limestone as will appear later.

About 150 yards northwest on the opposite side of the road and on the Cornelius Smith farm the upper part of the Putnam Hill is seen in an excavation for a spring. It lies at 1084 above sea and is a light bluish gray in color, much lighter than the Vanport. Only 1 foot of it is exposed and its thickness unknown.

North Benton. This village lies 2 miles northeast of Bests and the hill above the town reaches an elevation of 1127 which is sufficiently high to carry both of the above limestones but 50 feet of the hill top is sandstone. A well at Mr. Hammond's barn just across the roadway from the brick church penetrates a limestone which may be seen outcropping in the roadway east of the barn and near the northwest corner of the cemetery. It lies at 1069 and is the Howenstein limestone. Its thickness is not seen at this point but is probably 2 to 3 feet. Mr. Hammond reports 4 to 5 feet of black shale on top of the limestone. Sandstone clearly succeeds the shale as may be readily seen in the roadway above the church.

Near the northeast corner of the cemetery and 29 feet below the top of the limestone the base of a bed of fireclay occurs. This fireclay marks the horizon of the Upper Mercer limestone but neither the thickness of the fireclay nor what overlies it is exposed here. Two hundred yards or more down steam loose blocks of limestone are seen and are thought to be from this horizon. Nearly a half mile northeast of the cemetery on the O. F. Henry farm this limestone is exposed at 1048 above sea at its highest point. It undulates sharply dipping 4½ feet in 50 yards. It

measures from 2 to 3 feet in thickness, is blue-black and very fossiliferous. Here it is directly underlain by 2½ inches of blue and yellow clay succeeded by 14 inches of coal.

This limestone is seen again outcropping in the roadway ⅓ mile southeast of the village.

About ¼ mile north of the village on Island Creek, and near stream level a bed of coal is found. The bed has been opened but found to be too poor to mine. It lies at 1012 feet above sea and appears to be the coal belonging to the Lower Mercer limestone although no limestone is found at this horizon in this vicinity. This coal is of no value further than aiding in identifying horizons and its relations will be considered in this connection with the outcrops on Little Mill Creek. At various places from the North Benton Cemetery, below the fireclay noted, loose micaceous sandstone in thin layers can be seen down stream to the outcrop of the above coal. This interval of about 36 feet appears to be composed largely of this kind of rock. The interval, however, at first appears too great to be that between the Mercer Limestones, but it will be remembered that the elevation of 1048 above sea is on a crest of the Upper Mercer and a sharp dip is seen. The trough in all probability reaches 1042 or less. Again were the Lower Mercer present with a thickness of 3 feet and resting directly upon the coal, which it does not always do, the interval would be still further reduced and within the limit seen at Howenstein.

Little Mill Creek. This stream flows into the Mahoning River from the east and with its mouth located about 1 mile north of the O. F. Henry outcrop and near the Portage–Mahoning County line. This stream is designated *Little* Mill Creek to avoid confusion with another Mill Creek in the eastern end of the county. One and one-half miles east of its mouth and 2 miles northeast of North Benton several outcrops of limestones occur along this stream and its branches. They are the Mercer limestones. The Upper Mercer occurs in typical exposure in a small ravine a few rods east of Mr. Simon Hartzell's barn where it is 2½ to 3 feet thick and dips sharply toward the south. At a medium point its elevation is 1037 feet above sea. This stone is blue-gray to blue-black and weathers to a rusty brown. About ¼ mile south of this point a thin coal is seen in the shale and clay pit of the Dustman Brothers Pottery Plant which lies at about 1075 above sea and apparently marks the horizon of the Howenstein limestone but no limestone is present. Only dark shale and drift clay overlie this coal.

About the same distance north of the Hartzell outcrop the Lower Mercer becomes a very conspicuous stratum in the sides and floor of Little Mill Creek. About 150 yards above the highway bridge on the north and south road this stratum forms a fall

in the stream over a conspicuous overhanging ledge which extends from bank to bank. No better outcrop of the Lower Mercer is found anywhere than occurs here. At the fall the stratum lies in two layers in immediate contact and without any parting. The lower layer is 7 inches thick and the upper 2 feet, 5 inches. It is rather tough, blue-black, and quite fossiliferous. In the south bank in the roadway it lies at 1022 above sea, at the lowest point seen a few rods above the fall it lies 12 feet lower or a dip of 12 feet in a distance of about 150 yards. If the inclination observed in the cliff a short distance above the fall may be taken to indicate a continuation of the dip up to that point then this limestone in its trough probably lies 20 feet lower than at its crest near the bridge.

On Turkeybroth, the north branch of Little Mill Creek, at a point 4 or 5 hundred yards above the fall this limestone again rises and becomes the floor of the Turkeybroth for some distance where it lies at about 1015. Near the top of the cliff a short distance above the fall the Upper Mercer again outcrops and is 3 feet, 1 inch thick. Its top lies 16 feet, 8 inches above stream. But it does not lie 10 feet above the level of the Lower Mercer's crest at the bridge. The Upper Mercer is again quite well exposed for several hundred yards in the sides and bed of the south branch of Little Mill Creek. About 200 yards above the fork this stratum is seen in the south bank at 9 feet above stream, blue-black, very tough, and 3 feet, 2 inches thick with 10 inches of coal $1\frac{1}{2}$ feet beneath it. Up stream the limestone soon becomes the creek floor and is seen to undulate gently now above water and now below and gradually rising toward the east. For considerable distances where the stratum lies a little below water level and having been swept clean, there is seen to be a top layer 2 to 4 inches thick, which is jointed so regularly as to look very like street paving. The jointing planes not being equal distances apart divide the layer into rectangular blocks 4 to 10 inches wide and 6 to 15 inches long. The jointing lines are very distinct and present a striking appearance in the still water between the crests. It would seem that the blocks might be lifted easily but so tightly do they fit that it is with difficulty that one is raised from between its fellows. This pavement layer is more carbonaceous, nearly black, less tough, and much more fossiliferous than the thick layer beneath.

At the point where this stream bends to the south the limestone disappears and is seen to dip sharply to the southward. It is not seen again for nearly a half mile, and then reappears rising above the stream bed at a point south of where it was last seen and lies 6 or 8 feet higher. This outcrop occurs about 200 yards below Mr. John Helsel's barn. Both of these limestones where exposed in the stream bed are seen to be jointed and lie in heavy

massive blocks. The banks of the stream for several hundred yards below the falls are strewn with huge blocks as if distributed for some giant masonry. The blocks often measure 8, 10 or even 12 feet in length.

As seen at the fall and below the Lower Mercer is underlaid by 4 feet of fire-clay and sandy shale but no coal. A short distance below the bridge this limestone dies out, shale appears, and coaly shale comes in at the horizon of the base of the limestone and further down becomes a definite bed of coal of 4 to 6 inches thickness. This coal is traceable with a sandstone cover all the way to the Mahoning River. At the forks of the highway and just above the first bridge over Little Mill Creek this coal is 1 foot thick, lies at 1024, and is overlain by shaly micaceous sandstone. At a point about midway between the above two bridges on this creek this sandstone was formerly quarried. The coal is seen to undulate and is certainly the coal referred to on Island Creek near North Benton which at that point lies at 1012 above sea. It is certainly the coal belonging to the Lower Mercer limestone but the latter is not seen anywhere to the westward on either Little Mill Creek or the Mahoning River as far up the river as the Benton-Deerfield highway. There is another thin coal to be noted, however, in this connection which may easily cause confusion. About 300 yards down stream from the mine on Island Creek and at the bridge east of Benton Station this coal lies in the creek bed at 997 above sea and about 8 inches thick. A third of a mile northwest in the river bank just below the railroad river bridge this coal is 7 inches thick and lies at 1000 above sea or 18 feet below rail on the bridge. It is seen at numerous other points on the Mahoning and on Little Mill Creek and at 15 to 20 feet below the Lower Mercer Coal. The intervening rock is largely sandstone. It is of interest to note here that two coals occur below the Lower Mercer limestone at Lowellville; a 2-inch layer 2 feet below, and an 18-inch bed 13½ feet below.

It now remains to combine the several outcrops of limestone seen in the Best's Station–North Benton–Little Mill Creek vicinity into one section. From the data given it is clear that the horizons of the Lower Mercer, Upper Mercer, and Howenstein are found at North Benton. The mean elevation of the Lower Mercer on Little Mill Creek is 1016, of the Upper Mercer 1037. The Lower Mercer coal near North Benton lies at 1012 and were the limestone present above it in usual thickness its elevation would be 1015. The Upper Mercer at North Benton lies at its highest piont at 1048 but its mean elevation is quite probably about 1043. The Howenstein as seen at the cemetery lies at 1069. What is seen on Little Mill Creek confirms the identification of horizons at North Benton, and the outcrops at North Benton are sufficiently close together to be grouped in a single

section without allowance for dip. Three of the five limestones are so far accounted for at elevations as follows: 1015, 1043, and 1069 above sea. Those at Best's Station are to be added, but being 2 miles away dip must be considered. The nearest point for comparison of elevations of all five limestones is at Alliance. The outcrops at Best's Station are about 4½ miles from Alliance and those about North Benton about 7 miles, except the Howenstein outcrop which is about 6½. Comparing the elevations of the lower three at the two places, they are as follows:

	Alliance	North Benton	Difference
Howenstein	1008	1069	61
Upper Mercer	966	1043	77
Lower Mercer	945	1015	70

It appears at once that there is a dip toward Alliance from North Benton whatever it may be in any other direction. For the Mercer limestones it is 10 and 11 feet per mile, for the Howenstein a little over 9 feet per mile. It will be remembered, however, that the latter stratum lies relatively higher at Alliance than in the Nimishillen valley. Comparing the upper two limestones likewise they appear as follows:

	Alliance	Best's	Difference
Vanport	1081	1101	20
Putnam Hill	1032	1084	52

The first difference is not what would be expected from the dip found in the first three limestones, but the second corresponds very well giving a dip of about 11½ feet per mile. The Vanport clearly lies considerably lower relatively than at ony other place found, and its dip of less than 5 feet per mile is not representative of the general dip of the strata. Therefore in combining the outcrops at Best's and Benton a general dip of about 11 feet per mile must be used in adjusting the interval between the Howenstein and Putnam Hill limestones, and combining the outcrops for a section at North Benton the following elevations represent the horizons of the several limestones:

Vanport	1125
Putnam Hill	1106
Howenstein	1069
Upper Mercer	1043
Lower Mercer	1015

It will be observed at once that the elevation of 1125 for the Vanport does not conform to the 11 foot dip, but it is quite probable that it lies at about 1125 at this point since it lies only 17 feet above the Putnam Hill at Best's Station, which strongly suggests a thinning of intermediate strata in this region. It is true that the interval between the Lower Mercer and the Vanport would thus be only 110 feet, while the same interval at

Howenstein is 147 feet, at Alliance 136 feet, in central Mahoning County 122 feet, and at Lowellville 133 feet.

Probably the most striking fact is the rise in the strata toward Benton since this is in line with Howenstein and Alliance. But as before the writer accounts for this occurrence in part on the ground that an anticline lies to the east of Alliance and in going from this place to North Benton the northwest slope of the anticline is ascended.

MEANDER CREEK AND TRIBUTARIES.

This stream and its tributaries arise in the central part of Mahoning County and furnish the next good exposures of limestone.

Ellsworth. A half mile south of the village of Ellsworth and just below the fall at Club Lake in the bed of the west branch of Meander Creek the Lower Mercer occurs at 1023 feet above sea, is 3 feet thick and possesses its usual characters. In the south bank of this stream near the highway bridge an opening has been made into the coal belonging beneath this limestone. The coal was not seen but lies at about 1018. About ¼ mile below the highway bridge a 9-inch coal is exposed in a cliff with sandstone above it and lying at 1003 feet above sea. This is certainly the same coal seen on Little Mill Creek and on the Mahoning River. The elevation and interval between the coals are almost identical although the two localities are about 8 miles apart.

A few hundred yards below the above cliff on the south side of the creek occur conspicuous clay banks rich in beautiful crystals of selenite which have given the obscure village of Ellsworth a place of prominence with geologists and museums far and wide. The clay is a gray talcose glacial deposit.

At the Club Lake fall 14 feet above the limestone thin streaks of coal occur at the base of a massive sandstone. It is clearly the Upper Mercer coal but with its limestone displaced by the massive, coarse grained sandstone which contains numerous impressions of lepidodendrids, sigillarids, and calamities. The currents that prevented the formation of the limestone swept down the coal plants and entombed them in sand. No better display of fossil plants in sandstone is known to the writer than occurs in this stratum.

The bluish gray shale beneath the sandstone contains great numbers of beautifully preserved fern leaves and other plants.

Diehl Creek. At a point about 2 miles east and slightly south of Club Lake on Diehl Creek, a tributary of the middle branch of Meander, the Lower Mercer is again seen in the sides and bed of the creek and presenting the same appearance as seen on Little Mill Creek, but with less undulation. The stratum lies at 1024 feet above sea, is 2 feet 5 inches thick and in two layers, the

lower one being 5 inches. The two layers are a quite constant expression of this limestone throughout Mahoning County and wherever a good exposure of the entire thickness is seen this character is present. I. C. White in his report on Mercer Co., Pennsylvania, pointed out this feature, as noted in the first part of this paper. The most westerly point at which this feature has been observed in Mahoning County is at the fall on Little Mill Creek. The same character occurs at Shew's Mill in Stark County.

Lower Outcrop. On the middle branch of Meander Creek at a point about two-thirds of a mile southwest of the Diehl Creek outcrop and a short distance south of Mr. John Lower's barn the Upper Mercer is exposed in a ravine and lies at 1040. The stratum is not well exposed but is about 2 feet in thickness and is overlain by 33 inches of coal which has been mined to a small extent. The subjacent strata were not seen. This point is 2 miles southeastof Club Lake where the Upper Mercer Coal lies at 1037. These elevations indicate practically horizontal strata. The interval between the limestone and the coal at the lake is practically the same as that between the limestone on Diehl Creek and the limestone near the Lower barn. One would think dip must be counted but these elevations and measurements forbid it.

Bingham Outcrop. One and one-fourth miles west of the Lower outcrop and three-fourths of a mile a little east of south of Club Lake on the farm of E. W. Bingham a limestone lies at 1072 feet above sea. It is 15 to 18 inches thick and overlies a bed of coal which was formerly mined to a limited extent. This is 32 feet higher than the Upper Mercer and is certainly the Howenstein limestone. It lies 7 feet higher than the top of the heavy sandstone at Club Lake. North of the Bingham residence and on the farm of C. E. Bowman a bed of coal lies a few feet above the top of this standsone and is undoubtedly the same coal as on the Bingham farm.

Above the Howenstein limestone lies sandstone as seen in the hillside above the coal mine and in the roadway near the Bingham residence. Succeeding the massive sandstone a black coaly shale appears with its base at 1096 above sea. Mr. Bingham states that it is 13 feet thick and underlies much of the hill above the limestone and that it has been penetrated by drill in numerous places in the hope of finding a good bed of coal. A heavy coarse sandstone succeeds this shale to the top of the hill or to an elevation of about 1150. The structure of this hill from the limestone up is of much importance in the interpretation of the next outcrops to be noted.

Unger Outcrop. On Meander Creek one-fourth mile southwest of the southwest corner of Canfield Township and on the Unger farm an outcrop of limestone occurs a few hundred yards

southeast of the Unger barn. The stratum is black and 18 inches thick lying at 1082 above sea. This exposure is about 1½ miles south, and 2¼ miles east of the Bingham outcrop, and lies 10 feet higher. As noted in the Lower outcrop there is no evidence of dip in this locality toward the south or south-east so far as the writer has found. A few hundred yards above the Unger outcrop and directly in the southwest corner of Canfield Township on the Ewing farm a bed of coal lies at 1115 feet above sea and a few feet beneath this a second bed. The top of the upper bed is 33 feet above the Unger limestone, and the bottom of the 13 foot black shale on the Bingham farm lies 24 feet higher than the Bingham limestone or the *top* of the shale 37 feet higher. Above the limestone at both places there is sandstone; above the black shale on the Bingham farm and above the coal on the Ewing farm sandstone occurs. With no evidence of dip and with close correspondence of the strata in elevations and character, the conclusion that the limestone at Unger's is the Howenstein and that the Ewing coals are the equivalent of the black shale at Bingham's is inevitable. The coal on the Ewing farm was identified by Dr. Orton as the Canfield cannel coal, and the fragments of limestone found at the opening of the Ewing mine as the ferriferous limestone. [Ohio Geol. Sur. Vol. V, p. 31.] He further indicates that the dip is 15 or 20 per mile toward the southeast in this locality. Upon what is it based is not stated. The writer finds only evidence of little or no dip at all, and is unable to regard the Ewing coal other than that beneath the Putnam Hill limestone, and that the fragments of limestone found by Dr. Orton belong to that stratum. A comparison of the limestones, coals, and their elevations on the east side of Canfield Township with those at Lowellville leads to no other conclusion than that the Canfield Cannel Coal is the coal beneath the Vanport limestone as Dr. Orton identified it. The following are the elevations of the limestones on Meander Creek and those on the east side of Canfield Township:

Meander Creek	Canfield Township
(5) ————————	(5) Canfield Cannel Coal 1151
(4) Ewing Coal 1115	(4) Fireclay 1101
(3) Howenstein 1082	(3) Howenstein 1078
(2) Upper Mercer 1040	(2) Upper Mercer 1050
(1) Lower Mercer 1024	(1) Lower Mercer 1029

This table is the writer's interpretation of his findings based upon the number of strata, their elevations and their intervals. (1), (2), and (3) correspond well. (4) on the east side of Canfield clearly lies lower than usual but unmistakable.

The Ewing coal certainly appears to mark the Putnam Hill horizon in the southwest corner of Canfield Township.

The interval between (2) and (5) on the east side of the township is seen to be 101 feet, and it may be reasonably expected that about the same interval would occur on Meander Creek. At Howenstein it is 119 feet, at Alliance 115 feet, at Lowellville 115 feet. Since the Ewing outcrop is nearer east Canfield Township with the 101 foot interval, a 101 foot interval on Meander Creek seems entirely reasonable. The horizon of No. (5) on Meander Creek then would be about 1141 feet above sea, or about 26 feet above the Ewing coal.

Recourse to another measurement may be taken which tends to confirm the conclusion that the horizon of the Vanport lies higher than the Ewing coal. From the data on the strata at Alliance and southward and with the Upper Freeport limestone lying at 65 feet above the Middle Kittanning coal in the Minerva Tunnel-cut it will be seen that the interval between the Vanport and the Upper Freeport limestones is 121 feet in that locality. The Upper Freeport limestone is found on the Canfield-Greenford highway in the Goodman Hill at 1256 feet above sea. This point is one mile a little south of east from the Ewing mine, and the limestone is readily recognized as the Upper Freeport by its brecciated character and a minute coiled worm-like fossil in great numbers. The interval between the Ewing coal and the limestone is 141 feet. Dip, if there were evidence of it in this locatliy, would increase this measurement. As it is, it exceeds the first measurement by 20 feet which is near the interval between the Ewing coal and the horizon at which the previous calculation would place the Canfield Cannel or the coal beneath the Vanport limestone.

If the Ewing coal were the Canfield Cannel and the limestone found by Dr. Orton the Vanport, then the interval between the Lower Mercer and the Vanport limestone on Meander would be only 93 feet which is considerably less than the average interval.

Beardsley Outcrop. On the east branch of Meander Creek and about 1 mile northwest of the County Infirmary an outcrop of the Lower Mercer occurs on the farm of Edward Beardsley. Its average thickness is about 3 feet and was formerly quarried extensively and shipped to the furnaces at Leetonia. At 12 to 18 feet below the limestone a bed of coal is found which reaches a thickness of 3 feet and has been mined to a considerable extent for local use. It thickens and thins rapidly and at one point is seen to be only 13 inches. It is certainly the same coal seen below Club Lake and on Little Mill Creek. The limestone lies at about 1021 feet above sea.

Ripple Outcrop. South of West Austintown one-half mile along the Erie Railroad and just above the residence of Mr. John Ripple the Lower Mercer outcrops in the highway at 1028 above sea. In the mine beside the old Paint Works the limestone

measures 3 feet 6 inches. The rich bed of iron ore above it was formerly mined and used in the manufacture of paint.

This limestone is being burned for fertilizer on the John Fitch farm near West Austintown.

McMahon Outcrop. About $1\frac{1}{4}$ miles southeast of the Ripple outcrop an exposure of limestone occurs on McMahon Run and on the farm of Ambrose McMahon. The full thickness is not now exposed but reported to be 2 feet or more in a coal shaft at this point. Drillings close around gave a thickness of $2\frac{1}{2}$ to 3 feet. In one hole reported by Mr. McMahon a 2-foot coal was penetrated 10 feet above the limestone. As seen in the run the limestone lies at about 1040. The coal at the shaft lies 25 feet below the limestone or at 1015, but in one of the drill holes at 20 feet below that stratum. The limestone is overlain by a rich bed of iron ore as at the Ripple outcrop and would seem from all the data to be the Lower Mercer although 12 feet higher than at previous outcrop. Undulation will easily account for this difference. The 2 foot coal above it would seem to be the coal belonging to the Upper Mercer but no trace of this limestone or its coal is seen in the run above the shaft where the next 35 feet of strata are exposed.

Smith Corners. At Smith Corners about one mile a little south of east from the McMahon outcrop William Gardner penetrated a limestone of about 18 inches thickness at 1090 above sea. The dip toward the southeast in eastern Mahoning County is only about 5 feet per mile, the interval therefore of 55 feet indicates rather clearly that this is the Howenstein limestone. The McMahon outcrop, Smith Corners and Poland are nearly in line and the matter of dip in that direction will be considered further under Poland outcrops.

MILL CREEK AND TRIBUTARIES.

This stream empties into the Mahoning River at Youngstown after crossing the eastern end of Mahoning County from south to north. Its bed for more than 7 miles from its mouth lies below the horizon of the Lower Mercer limestone, and the seanty outcrops of the limestones, therefore, are found on its tributaries.

Facodi Outcrop. In the first ravine to the east above the fall at the old Lanterman Mill on Mill Creek, the Lower Mercer is first seen on the land of Una Facodi at 1010 feet above sea. The exposure is poor and the thickness not seen. It is underlain by gray sandy shale and flaggy sandstone down to Mill Creek. This sandstone is the Upper Massillon and it constitutes the rock walls of Mill Creek gorge.

Lanterman Outcrop. About one-fourth mile south of the Facodi outcrop and on the German Lanterman farm the Lower Mercer outcrops in a ravine which crosses the north and south

highway. It was formerly quarried on both sides of the ravine for some distance and burned for lime. At this point it lies at 1007 above sea.

Baldwin Outcrop. A half mile south of the last outcrop and on the Jesse Baldwin farm this same stratum may again be seen in a ravine in the rear of the Baldwin residence where it is 2 feet, 3 inches thick and overlies 18 inches of coal which was formerly mined on this farm to a limited extent. By topographic map the limestone lies about 1010 above sea. About 200 yards east of this point and across the road fragments of a limestone are lifted in plowing and the stratum would seem to lie about 1050 above sea.

Davis Well. This elevation would seem to be confirmed by penetrating a limestone at 1050 in a well at the residence of George E. Davis on the Youngstown-Boardman pike. The Davis well is ½ mile southeast of the Baldwin outcrop. It would seem that the second limestone is the Upper Mercer. If it is the Upper Mercer the interval is greater than anywhere else found.

Moyer Spring. At a point ½ mile south of the Davis well and 1 mile southeast of the Baldwin outcrop a limestone is found in a spring at the sawmill on the Samuel Moyer farm and lies at 1039 above sea.

Geiger Well. On the C. T. Geiger farm ½ mile southeast of the Moyer spring a limestone was penetrated in a test-well at 9 feet lower than in the Moyer Spring.

Walters Well. At the residence of E. C. Walters 1 mile southwest of the Moyer Spring a limestone occurs in the well at 1018 above sea and about 500 yards northwest of the Walters residence the Lower Mercer is exposed on Mill Creek at about 1000 above sea. As seen here this stratum is 2 feet, 4 inches in thickness and presents its usual characters. It directly overlies a black coaly shale varying from 0 to 18 inches in thickness.

Greenhouse Hill. Returning to the vicinity of Youngstown a third limestone is found ¾ mile east of the Lanterman outcrop and ¼ mile north of the township line on the Youngstown-Boardman pike. It outcrops in the gutter on either side of the pike a little above the greenhouse. The limestone is dark blue, fossiliferous, 2 feet thick, underlain by coaly shale, and lies at 1076 elevation. No other outcrop of it was found in this locality. The Lanterman, Baldwin, Davis well, and Greenhouse Hill limestones are sufficiently close together to conclude from them that the limestones found at these points are the Lower Mercer, Upper Mercer and the Howenstein.

Dr. Newberry in his report on Mahoning County gives a section of a boring made near the south side of Youngstown Township in which three limestones were penetrated. [Ohio. Geol. Sur. Vol. III, p. 803.] They are between tops, lower and middle

35 feet, middle and upper 39 feet. These are without doubt the same three limestones noted above. By boring the interval between the upper and lower is 74 feet; as observed in outcrop 66 feet not counting 4 or 5 feet for dip. Furthermore, only the hilltops on the south side of Youngstown Township reach an elevation of 1100 feet, and Greenhouse hill is one of them with the Howenstein at 1076 and near its top. Dr. Orton regarded this upper limestone as the Putnam Hill. [Ohio Geol. Sur. Vol. V, pp. 29-30.] But a comparison of the various sections unmistakably indicates that it is the Howenstein. The several other occurrences of limestone at various elevations as given above indicate that pronounced undulation exists in this locality in the lower limestones.

Indian Creek Outcrops. This stream is a tributary of Mill Creek and has cut a deep course in the southeast quarter of Canfield Township exposing coals and limestones.

On the Jonas Christman farm in the bed of Indian Creek at a point ½ mile west of the township line the Upper Mercer lies at 1039 feet above sea, is over 2 feet thick, and rests upon 14 to 18 inches of good coal. The limestone was formerly quarried and burned with the coal. On the same farm and on the south side of the creek a bed of coal was formerly mined which carries lenticular masses of limestone lying at 1064 above sea. These lenses are often beautiful septaria 12 to 18 inches in diameter and quite fossiliferous. The septarian character is well shown in a ravine on the north side of the creek several hundred yards above the outcrop in the creek bed. The coal underlying the limestone lenses is 18 to 24 inches thick and was formerly mined on the William Swanston farm. Seventy-three feet above the lenses lies the Canfield Cannel Coal at about 1139 above sea.

Dr. Orton identified these limestones and coals as the Lower and Upper Mercer and gave an interval of 85 feet between the coal under the limestone lenses and the cannel seam. Undulation will easily account for difference in interval, but the lenses are certainly the Howenstein limestone as will appear a little later.

On the Canfield-Boardman road in the Heintzelman hill ¼ mile west of the Canfield-Boardman line a bed of fireclay occurs at 1072. About 300 yards northwest of this point a mine has been opened in an 18 inch coal which carries limestone lenses lying at 1078 above sea. This is beyond question the same horizon noted on Indian Creek 1 mile south.

Neff Run Outcrop. About 300 yards northwest of this mine in a ravine on Neff Run, a tributary of Indian Creek, a 2-foot limestone occurs on the Martin Neff farm and rests directly upon a 20-inch coal. This limestone lies at about 1050 above sea. Recently Mr. Neff explored for the Sharon coal and in a drill hole close beside the run and below the horizon of the above limestone

penetrated 61 feet of drift. A little north of the run and above the limestone two limestones were penetrated. The upper one 2½ feet thick with 16 inches of coal directly beneath it, the lower one 3 feet thick and no coal beneath, and 21 feet between tops of the limestones. These facts are perfectly clear. The lenticular limestone is the Howenstein; the outcrop in the ravine at 1050, and the upper one in the drill hole, is the Upper Mercer; the 3-foot limestone in the drill hole is the Lower Mercer.

The three limestones on the east side of Canfield Township are in harmony with the section on Meander Creek 5 miles to the west; they agree perfectly with the section on Yellow Creek 5½ miles to the east; they are in entire accord with the findings in the vicinity of Youngstown 4 miles northeast; and they answer closely to the facts found on McMahon Run and at Smith Corners 4 or 5 miles northwest.

The section on Neff Run with the Lower Mercer at 1029, the Upper Mercer at 1050, and the Howenstein at 1078 combined with the measurement between the Howenstein and the cannel coal as found on Indian Creek gives the entire interval between the Lower Mercer and the Vanport horizons a measurement of 122 feet. The interval of 73 feet between the Howenstein and the cannel coal was nowhere found well exposed, but somewhere near the middle of it we would expect to find some trace of the horizon of the Putnam Hill limestone. No trace was seen in outcrop but in a drill hole on the Neff farm a few hundred yards north of the old mine in the cannel coal on the William Swanston farm a driller reports 8 feet of fireclay 50 feet below the cannel coal. The top of this clay certainly marks the Putnam Hill horizon. At 119 feet below the cannel coal a 3-foot limestone was penetrated which is undoubtedly the Lower Mercer. The following section, therefore, indicates the relations of the limestones or their horizons for the Neff Run locality on the east side of Canfield Township:

Vanport limestone (cannel coal)	1151
Putnam Hill limestone (fireclay)	1101
Howenstein limestone (lenses)	1078
Upper Mercer limestone	1050
Lower Mercer limestone	1029

DIP OF STRATA IN CENTRAL MAHONING COUNTY.

The matter of dip presents some points of interest in central Mahoning County. The Lower Mercer dips southeast from McMahon Run to Indian Creek about 22 feet in 5½ miles or about 4 feet per mile. The Howenstein dips more south than east between Smith Corners and Indian Creek 26 feet in 4½ miles. The average dip is therefore seen to be about 5 feet per mile in this direction.

From Lower Outcrop nearly due east to Indian Creek the Upper Mercer dips 1 foot in 5½ miles. The Howenstein dips in the same direction from Bingham Outcrop to Indian Creek 8 feet in nearly 7 miles. The Lower Mercer rises from Club Lake to Neff Run in a direction 7½ miles east and 1 mile north 6 feet in 7½ miles. It is seen at once that the strata lie almost horizontally from east to west in the center of the county.

From Neff Run to Lanterman Outcrop more north than east the Lower Mercer falls 19 feet in 3½ miles, whereas it would be expected to rise judging from its position to the west of Neff Run. From the same run to Davis well very nearly northeast the Upper Mercer lies horizontally having an elevation of 1050 at each place and 3½ miles between. From Neff Run to Greenhouse Hill exactly northeast the Howenstein falls 2 feet in 4 miles. The average for the three strata is seen to be about a 2-foot fall per mile. In a direction so much north of east a rise of several feet per mile would be expected.

From the Beardsley Outcrop to Neff Run in a direction 1½ miles south of east the Lower Mercer rises 8 feet in 4 miles. Further comment on the dip and position of the strata in central Mahoning County will be made in connection with the Yellow Creek and Lowellville sections.

YELLOW CREEK.

This stream is a tributary of Mahoning River and flows northward nearly parallel to Mill Creek half way between the latter and the state line. It has a fall of about 210 feet in 5 miles and its rapid current has cut a deep gorge from the village of Poland to its mouth at Struthers. Accordingly unusually good exposures of the Potsville formation are afforded.

Poland Outcrops. At the village of Poland two outcrops of limestone occur. The first is seen on the north side just below the cemetery forming a conspicuous ledge and water fall in Yellow Creek. It is the Lower Mercer and lies at 990 feet above sea. The stratum presents here that peculiarity of two layers noted elsewhere. The upper layer measures 2 feet, 3 inches and the lower 7 inches. Resting directly upon the heavy bed is a 2-inch very impure layer of limestone of cone-in-cone structure which breaks easily and shows this peculiar structure quite admirably. The heavy bed is bluish gray, tough, fossiliferous, and sparkles with crinoid stems and calcite crystals. The limestone is directly underlain by black carbonaceous shale which is extremely fossiliferous. Seventeen feet of yellowish-gray flaggy sandstone overlies this limestone at this point.

One and one-half miles from the Mahoning River the City of Youngstown has built a dam on Yellow Creek, the head water of which is found a few hundred yards below the above outcrop.

In a cliff at the head of still water the Lower Mercer is again well exposed as a conspicuous middle stratum of 3 feet thickness in the cliff face and lying at its top 9 feet above dam level. A 5-inch impure cannel coal lies $4\frac{1}{2}$ feet below its base. In the second ravine south of the spillway the Lower Mercer is again seen and lies 4 feet higher than in the above cliff, a mile distant. The dam level is about 980 feet above sea.

The second limestone at Poland outcrops on the south side of the village in the creek bank in the rear of the Presbyterian church. The stratum is clearly the Upper Mercer and lies at 1013 above sea. As seen here it rises a few feet above, then sinks beneath the level of the Poland Mill Dam.

Burgess Run Outcrop. One and one-quarter miles south of Poland on Burgess Run, a tributary of Yellow Creek, a third limestone outcrops at 1050 in the run bank near the highway bridge and on the farm of D. W. Walker. The stratum is nearly black and 2 to $2\frac{1}{2}$ feet in thickness. It is underlain by 18 inches of coal 15 inches of which is cannel. The limestone is overlain by sandstone as seen above the highway. This is clearly the Howenstein limestone although it lies lower than in the outcrops noted on Neff Run, at Smith Corners and in Greenhouse Hill. But it is also noticed that the Mercer limestones lie correspondingly lower.

DIP OF STRATA FROM CENTRAL TO EASTERN MAHONING COUNTY.

Poland is directly east of the Neff Run outcrops $5\frac{1}{2}$ miles and a comparison of the elevations of the three strata at once reveals a dip toward the east which was not found the case across Canfield Township.

Neff Run		Poland	
Howenstein	1078	Howenstein	1055
Upper Mercer	1050	Upper Mercer	1013
Lower Mercer	1029	Lower Mercer	990

The Howenstein is not found at Poland but the dip southeast from Greenhouse Hill to Burgess Run is 5 feet per mile, hence the horizon of this limestone is about 1055 at Poland. These elevations show that the Howenstein dips toward the east slightly over 4 feet per mile, the Upper and Lower Mercer 7 feet per mile.

The elevations at Poland may be compared with one other set. The outcrops south of Youngstown and those at Poland lie in a line extending northwest and southeast.

Youngstown			Poland	
(Greenhouse Hill)	Howenstein	1076	Howenstein	1055
(Davis Well)	Upper Mercer	1050	Upper Mercer	1013
(Faeodi)	Lower Mercer	1010	Lower Mercer	990

The distance between the first two points is 4 miles hence the Howenstein dips about 5 feet per mile which it is seen to do between Greenhouse Hill and Burgess Run. Between the second two points the distance is 3½ miles and the dip 11 feet per mile. This is undoubtedly due to this limestone lying much farther from the Lower Mercer at Davis Well than is usual, and therefore not representative of the general southeasterly dip of the strata. The Howenstein and Lower Mercer may be taken as more correctly expressing the general dip. Between the third two points the distance is 1½ miles with a dip of 4½ feet per mile.

CANFIELD ANTICLINE.

It will be recalled that in the interpretation of the Alliance section that facts seem to point to the existence of a fold lying east of that city. The writer believes that the data found in Mahoning County fully warrant this conclusion. The fold is a broad low one and seems to lie through the center of the county with Canfield somewhere near the crest. The horizons of all the limestones lie higher in Central Mahoning County than at Alliance or Poland. The existence of nearly horizontal strata from west to east in Canfield Township, and of marked dip in the same direction from the east side of the township toward Poland indicate such a fold. The fold is sufficiently low that the normal dip of the strata toward the southeast from Ellsworth and northwestern Canfield township is overcome causing the strata to lie almost horizontally, or with a slight rise in that direction. The unexpected fall in the strata toward the northeast from Neff Run, where a rise would be looked for, indicates a dying out of the fold in the vicinity of Youngstown. The rise in the strata from Alliance toward North Benton is believed to be due in part to ascending diagonally the west slope of this fold. Lastly, southeast of Alliance and in northwestern Columbiana County oil is found in many wells. Four miles southeast a good producing field is found. Six miles south and 2 miles east in the vicinity of Homeworth two other fields are found. Again, 8 miles southeast of Alliance a gas field occurs in the vicinity of North Georgetown. The position of these fields shows a general northeast and southwest direction. A distance of 4 miles from northwest to southeast across this belt of fields conforms exactly to facts found in central Mahoning County and the fields are certainly associated with the Canfield Anticline.

Gorge Outcrop. The three limestones already considered on this creek are the ones to be expected but another calls for attention. It lies below the Upper Massillon sandstone and therefore appears only in the lower part of the Yellow Creek gorge. This limestone is seen in the creek bed and in the north wall of the gorge about 4 or 5 hundred yards below Yellow Creek Dam,

and lies at about 884 feet above sea. It is black, tough, very hard, without fossils, somewhat concretionery in appearance, and 6 to 15 inches in thickness. The limestone lies 6 feet above stream level as seen in the cliff and near the middle of a 12-foot black and gray shale. Two thin seams of coal are seen above the limestone, one at 9½ feet and the other at 15 feet above, and seem to hold the horizon of the Quakertown coal.

The limestone lies 109 feet below the top of the Lower Mercer as seen in the ravine south of the spillway. Nearly 80 feet of the interval between the two limestones is occupied by the heavy sandstone which is very unevenly bedded and in places sinks down cutting out the upper coal.

Further comment on this limestone will be made in connection with the Lowellville section.

LOWELLVILLE SECTION.

This village is situated in the gorge, or deep narrow valley of the Mahoning River 1 mile west of the state line. Water level at the Lowellville River Bridge is 807 feet above sea and the borders of the gorge reach 1140 feet above or more. In places the gorge borders are less than 1 mile apart at 300 feet above the river and as would be expected numerous deep ravines trench the steep sides of the valley.

Furnace Run may be taken as typical of these ravines and as affording a typical section in the vicinity of Lowellville. This ravine lies on the south side of the river and immediately beside the highway leading south from the village. The mouth of the ravine is seen at the furnaces of *The Ohio Iron and Steel Company*.

Ascending this ravine the Mississippian-Pennsylvanian unconformity is seen at different places and with hilltops of the dove-colored Cuyahoga more than 100 feet above the river. About 200 yards east of the mouth of this ravine a mine is opened in the Sharon coal which lies at 848 feet above sea and lying in a narrow trough between ridges of the Cuyahoga formation. In the bed of Furnace Run about half-way between the Pennsylvania Railroad and its switch leading to the stone quarry the first limestone is found lying at 912 above sea. Further mention of this limestone is deferred to the close of the discussion on the Lowellville section. At the lower end of the culvert under the above switch the Lower Mercer limestone occurs in the ravine bed at 995 feet above sea. It is 2 feet 6 inches thick and a dark bluish-gray in color. A 2-inch coal occurs 2 feet below it and an 18-inch bed 13 feet 6 inches below as seen 50 yards below the culvert. The 18-inch coal seems to be the same bed found on Meander and Little Mill Creeks. The limestone is overlain by iron ore.

The Upper Mercer is seen directly above the preceding limestone at the culvert, and lies at 1020 feet above sea. It is 2 feet 4 inches thick is slightly darker in color and contains the same fossils found in the Lower Mercer, and is immediately underlain by 15 inches of coal.

At 23 feet above the latter limestone or at 1043 feet above sea a thin bed of coal occurs which ranges from 3 to 6 inches in thickness as seen at several outcrops along the east side of the ravine. This is undoubtedly the coal seen beneath the Howenstein 4 miles southwest on Burgess Run and the representative of the coaly shale beneath that limestone seen on Greenhouse Hill 6½ miles a little north of west. The interval between the Upper Mercer and this coal is chiefly shale and contains two other coals. The first is 14 inches thick with only 2 feet 10 inches between it and the limestone. The second coal is 5 inches thick with its top 7 feet 10 inches above the limestone. Coal so close above a limestone is unusual. But it will be remembered that this is exactly the case in the Lower outcrop of this same limestone, and black coaly shale is found directly above the same stratum on Little Mill Creek at the point where it turns southward. Almost an exact duplicate of the facts found on Furnace Run immediately above the Upper Mercer is found on Little Mill Creek. Two beds of coal with clay and shale beneath each occur at the former place and two beds of black or coaly shale with clay and shale beneath each occur at the latter. This peculiarity of the Upper Mercer being sandwiched between two coals is not known to the writer to occur outside of Mahoning County.

At 1078 feet above sea another coal and fireclay is found. It is exposed in the roadway about 50 feet south of the highway bridge over the switch to the quarry. It is also exposed in the switch cut east of the bridge near the crusher, and again in the ravine about 300 yards southwest of the highway bridge. At the latter point it is 5 inches thick but thinner in the others and is underlain by 2 to 3 feet of clay and sandy shale which grades quickly in coarse shaly sandstone the latter filling the interval down to the next coal below. This coal and fireclay certainly mark the horizon of the Putnam Hill limestone. The sandstone between these two coals is in harmony with facts found on Burgess Run, Neff Run, at Smith's Corners at the Bingham outcrop, the Ewing outcrop, and at North Benton; or in brief, sandstone prevails between these two horizons through Mahoning County.

The coal at the horizon of the Putnam Hill limestone is the last noteworthy stratum to be seen at the head of the ravine. But 200 yards to the left of the ravine and at the top of the hill the extensive quarry in the Vanport limestone occurs. This stratum shows marked undulation. The top as seen at the

north side of the quarry at the mouth of the quarry drain-tunnel lies at 1115 above sea with a thickness of 12 feet. The thin coal accompanying the limestone, the "Scrubgrass" of Pennsylvania and the "Canfield cannel" of Ohio, lies immediately beneath it at 1103 above sea. In the drain ditch leading to the tunnel and 110 yards distant the same coal lies at 1120½ feet above sea, the limestone making an equal rise. This is the greatest elevation at which the coal was found. In the highway 150 yards south of the northwest corner of the quarry the greatest height of the limestone is found at 1138 feet above sea, but the limestone is 16 feet thick at this point. The average elevation is about 1128 feet above sea, and the average thickness about 14 feet.

As seen at the tunnel mouth the lower 8 feet of the limestone have a dark blue color and are less pure than the upper part. The upper 4 feet are a much lighter blue, purer and lie in better defined beds than the lower part. As seen in the southwest corner of the quarry the first 3 feet 5 inches of the limestone are shaly, blue in color and becoming firmer toward the top. The next 4 feet 4 inches are bluish-gray, darker below and lighter above, and in 4 fairly definite layers. The upper 8 feet 2 inches are gray with a bluish tint below, and in 11 fairly definite layers but not generally continuous. They often split into more layers, are only fairly tough and break into rather cubical blocks.

This limestone as it occurs at Lowellville is exceedingly fossiliferous and contains more species of fossils than any of the other limestones or possibly more than all the others combined. It is especially rich in gasteropods.

At every point where the top of this stratum is exposed it shows the smoothing, scratching, and grooving of glacial action. This limestone has been quarried for many years for use in the furnaces, and at present is being quarried extensively on the W. M. Arel farm.

One-half mile south of the quarry on the T. M. Moore farm openings in the Lower Kittanning coal may be seen at 1177 feet above sea. Considerable coal was formerly mined for local use but the mines have long since been abandoned. The entire interval between the top of the limestone and the top of this coal is covered.

The several horizons of limestone occurring below the Lower Kittanning coal down to, and including the Lower Mercer have been considered at numerous points across the two counties. We may now turn to a consideration of an earlier Pennsylvanian limestone than the Lower Mercer, the presence of which has been noted at several points. As stated at the beginning of the Lowellville section this limestone is seen in the ravine bed about midway between the furnaces and the switch leading to the quarry and at its highest point is 912 feet above sea. It lies 83

feet below the Lower Mercer limestone and 64 feet above the level of the Sharon coal at the base of the shaft. Its position seems to be about the horizon of the Quarkertown coal, but the only suggestion of an associated coal is a considerable thickness of black shale overlying it, which is quite fissile, fairly tough and lifting in broad sheets particularly the first few feet above the limestone. About one foot of the shale above the limestone is somewhat calcareous responding readily to acid, and suggests that at no great distance it may become limestone. This black shale is in harmony with the gray and black shale with the two thin seams of coal found above the limestone in the Yellow Creek gorge.

Being covered the character of the strata immediately beneath the limestone was not seen. A little below, however, massive layers of sandstone appear which are certainly the upper part of the Lower Massillon sandstone, or Lower Connoquenessing of Pennsylvania. The limestone is black, very hard, tough, and apparently in one layer. It is 2 feet or more in thickness—the full thickness not being obtained due to a sharp dip down stream concealing its base. It is very fossiliferous, the white shells and crinoid stems presenting a striking appearance in the black matrix. A few species of brachiopods and fragments of crinoid stems predominate. The latter are often 6 or 8 inches long, as they also are in the Vanport in the quarry above, and lying horizontally with the section markings showing plainly they somewhat resemble worms, and the uninitiated point them out and confidently inform one that they are petrified worms.

Newberry in his report on Mahoning County, and in a section on Grindstone Run indicates the presence at this horizon of a "Dark silicious limestone" 1 foot in thickness. [Ohio Geol. Sur. Vol. III, opp. p. 804.] He nowhere else describes or mentions it so far as the writer is aware.

It will be recalled that a black limestone outcrops in the Yellow Creek gorge at 884 feet above sea. This outcrop is about 2½ miles west of Furnace Run, and while it lies 28 feet lower than the outcrop on the latter run it is certainly the same stratum.

In a test well on the C. T. Geiger farm located near the Youngstown–Boardman pike and about 1 mile north of Boardman Center and 3¾ miles due west of the Yellow Creek outcrop, a 3 foot black limestone was reached at 910 feet above sea. It lies 111 feet below the Lower Mercer limestone and 47 feet above the Sharon coal which is 2 feet thick in this well and lies at 863 feet above sea.

It will be recalled that in the Alliance section an unknown limestone of 5 feet thickness was struck at 882 above sea and at

63 feet below the Lower Mercer. A 2 foot coal also occurs in the Alliance well at 60 feet below this limestone.

Mr. Thomas Hyland, a well driller of Columbiana, Ohio, reports to the writer that at numerous points south of Youngstown and as far as 10 or 15 miles east of the state line he has penetrated a hard black limestone full of beautiful white shells and lying not far above the Block Coal and lower than any other limestone known to him.

All of the above data point unmistakably to another limestone of considerable extent in the Lower Coal Measures of this region. It is shown to extend at least as far west as Alliance and in heavier body at this point than anywhere else found. So far as is known to the writer the only outcrops of this limestone occur in Mahoning County and since the best outcrop occurs at Lowellville it may be called the *Lowellville Limestone*.

CONCLUSION.

The object of this study has been to ascertain the number, the relation, the position, the continuity, and the character of these limestones below the Lower Kittanning coal in the territory outlined at the beginning of this paper. The principal facts gleaned may be set forth briefly in conclusion.

1. There are six limestone horizons below the Lower Kittanning coal in Stark and Mahoning Counties. The lowest and earliest of these is the Lowellville which was first observed by Newberry on "Grindstone Run" at Lowellville. It seems to lie just below the horizon of the Quakertown coal, and its known outcrops are limited to Mahoning County.

2. The second limestone is the Lower Mercer and was first noted by H. D. Rogers in 1858 in Mercer County, Pennsylvania. The two layer character pointed out by I. C. White, as occurring in Mercer County, is characteristic of this limestone in Mahoning County and occurs at Shew's Mill below Howenstein in Stark County. This limestone has been regarded the most persistent of the Lower Coal Measure limestones. Whatever may be said of it elsewhere, in these counties it is absent equally as often as its companion the Upper Mercer.

3. Two beds of coal occur quite generally below the Lower Mercer limestone. The upper one is usually thin and of little or no value. The lower one is of mineable thickness in places, lies 10 to 22 feet below the limestone, and is known as the Lower Mercer coal. At Shew's Mill it lies 22 feet below; 12 to 20 feet below on Little Mill Creek and Mahoning River; 10 to 17 below on Infirmary Run; and 13 below on Furnace Run.

4. The third limestone is the Upper Mercer, first recognized by Rogers on the Mahoning River and later by White in Mercer County as the Upper Mercer limestone. In Mahoning County

this limestone has the peculiarity of being interposed between two beds of coal both of which reach mineable thickness in some places. The Pennsylvania geologists have said this limestone is sparing in outcrop in Mercer County and seldom seen where the Lower Mercer is found. Had the excellent expression of this stratum in Mahoning County been seen at that time, the name Upper Mercer would quite probably never have appeared. In both counties it is sometimes absent but is present equally as often as the Lower Mercer.

Rogers states that this limestone is interposed immediately under the Tionesta sandstone (Homewood sandstone) in the vicinity of New Castle, Pennsylvania, [Geology, Pennsylvania, Vol. II, Part I, p. 489], and White in his section on the Ohio-Pennsylvania line on the Mahoning River shows the top of the Homewood sandstone to be 30 feet above the top of the Upper Mercer limestone. [U. S. Geol. Sur. Bul. 65, p. 191]. These are important points in correlating the horizons traced across the two counties with those beyond the state line. The horizons of doubtful correlation are, particularly, the Brookville coal, Clarion coal, and Putnam Hill limestone.

5. The Howenstein is the fourth limestone and is traceable across the two counties. It is last seen in full development, and without suggestion of disappearing, on Burgess Run. Its horizon is certainly marked by the coal at 1043 on Furnace Run. From White's section and the Furnace Run section the writer is unable to reach any other conclusion than that the Howenstein limestone caps the Brookville coal. The Homewood sandstone so conspicuous in Pennsylvania thins down on entering Ohio and becomes shale in the Furnace Run section but regains its massive character locally as seen at Club Lake where it is 28 feet thick, and rests upon a remnant of the Upper Mercer coal. Failing as it does it is no longer a guide to mark the top of the Pottsville formation in these counties, but the Howenstein limestone directly overlying the Brookville coal comes in to be the guide in finding the horizons.

6. The Putnam Hill, first recognized by Andrews, 1869, in Putnam Hill at Zanesville, Ohio, is the fifth limestone. It lies in rather heavy body through Stark County and in western Mahoning County. It thins out toward the east and is absent in the eastern part of the county. The last trace of it was found at the Ewing mine in southwestern Canfield Township by Dr. Orton. The coal at 1078 feet above sea in the Furnace Run section marks its horizon and appears to be the Clarion coal of western Pennsylvania. It is worthy of note that in the interval between the Brookville, and clarion coals sandstone prevails through Mahoning County and is present through central

Stark County but with less prominence. It is usually shaly or flaggy and soft, but occasionally it becomes fairly firm and massive, yet nowhere showing the massiveness of the Homewood at Club Lake.

7. The sixth and highest of these limestones is the Vanport named by Clapp in 1904 but well known previously as the Ferriferous limestone. This stratum enters Ohio at Lowellville with a thickness of 16 feet, but suddenly dies out westward. In central Mahoning County its coal thickens and becomes the well known "Canfield Cannel Coal" but without its limestone covering. In southwestern Mahoning County the Vanport reappears and is found at different points in considerable body at least as far westward as central Stark County. The outcrops of the Vanport and Putnam Hill overlap, and the two are sometimes present in the same section. This is particularly true in the vicinity of Middle Branch in Stark County where the Putnam Hill reaches its maximum development and with the Vanport above it in heavy body. Southward from this locality the Putnam Hill maintains a fairly heavy body but the Vanport again dies out at Canton and has only feeble expression in the southern part of the county.

8. All of the limestones undulate and this occasionally becomes very pronounced. Variation in the intervals between them is more often due to undulation than to a general thickening or thinning of intermediate strata.

9. The dip of the strata in the region covered is decidedly variable and a uniform dip of 15 to 20 feet per mile toward the southeast is untenable. The variation appears to be due to low folds one of which seems to extend through western Columbiana County and through central Mahoning County, and with the crest in the vicinity of the village of Canfield. A second fold is thought to extend through the western part of Stark County and with the crest to the west of Canton.

TABLE OF OUTCROPS AND ELEVATIONS.

For convenience of reference the various outcrops and places at which limestone occurs with the identification and elevation are given in tabular form. In a few instances the limestone is absent, but its horizon is clearly marked by fireclay or coal, or both.

TABLE OF LIMESTONES AND ELEVATIONS

Place	Name of Limestone					
	Lowell-ville	Low. Mer.	Up. Mer.	Howen-stein	Put. Hill	Van-port
Howenstein	....	939	967	991	1051	1086
North Industry	....	....	979	....	1057	....
S. W. Canton	....	....	1003	1025	1075	....
N. W. Canton	....	....	....	....	1090	....
Worstler Outcrop	....	....	....	....	1120	....
Werner Outcrop	....	....	....	....	1130	....
Cement Plant	....	....	....	....	1143	1180
Carr Outcrop	....	....	....	....	....	1117
Ellett Outcrop	....	....	....	....	....	1081
Alliance	882	945	966	1008	1032	....
Best's Station	....	....	....	....	1084	1101
North Benton	....	1015	1043	1069	....	....
Henry Outcrop	....	....	1048	....	....	....
Hartzell Outcrop	....	....	1037	....	....	....
Pottery Plant	....	....	....	1075	....	....
Little Mill Cr.	....	1015	....	....	....	....
Ellsworth	....	1023	....	....	....	....
Diehl Creek	....	1024	....	....	....	....
Lower Outcrop	....	....	1040	....	....	....
Bingham Outcrop	....	....	....	1072	....	....
Unger Outcrop	....	....	....	1082	....	....
Ewing Mine	....	....	....	....	1115	....
Beardsley Outcrop	....	1021	....	....	....	....
Ripple Outcrop	....	1028	....	....	....	....
McMahon Outcrop	....	1040	....	....	....	....
Smith Corners	....	....	....	1090	....	....
Faeodi Outcrop	....	1010	....	....	....	....
Lanterman Outcrop	....	1007	....	....	....	....
Baldwin Outcrop	....	1010	1050	....	....	....
Davis Well	....	....	1050	....	....	....
Moyer Spring	....	1030	....	....	....	....
Geiger Well	910	1021	....	....	....	....
Walters Well	....	1018	....	....	....	....
Greenhouse Hill	....	....	....	1076	....	....
Indian Creek	....	....	1039	1064	1089	1139
Neff Run	....	1029	1050	1078	....	....
Yellow Cr. Gorge	884	....	....	....	....	....
Poland	....	990	1013	....	....	....
Burgess Run	....	....	....	1050	....	....
Furnace Run	912	995	1020	1043	1078	1128

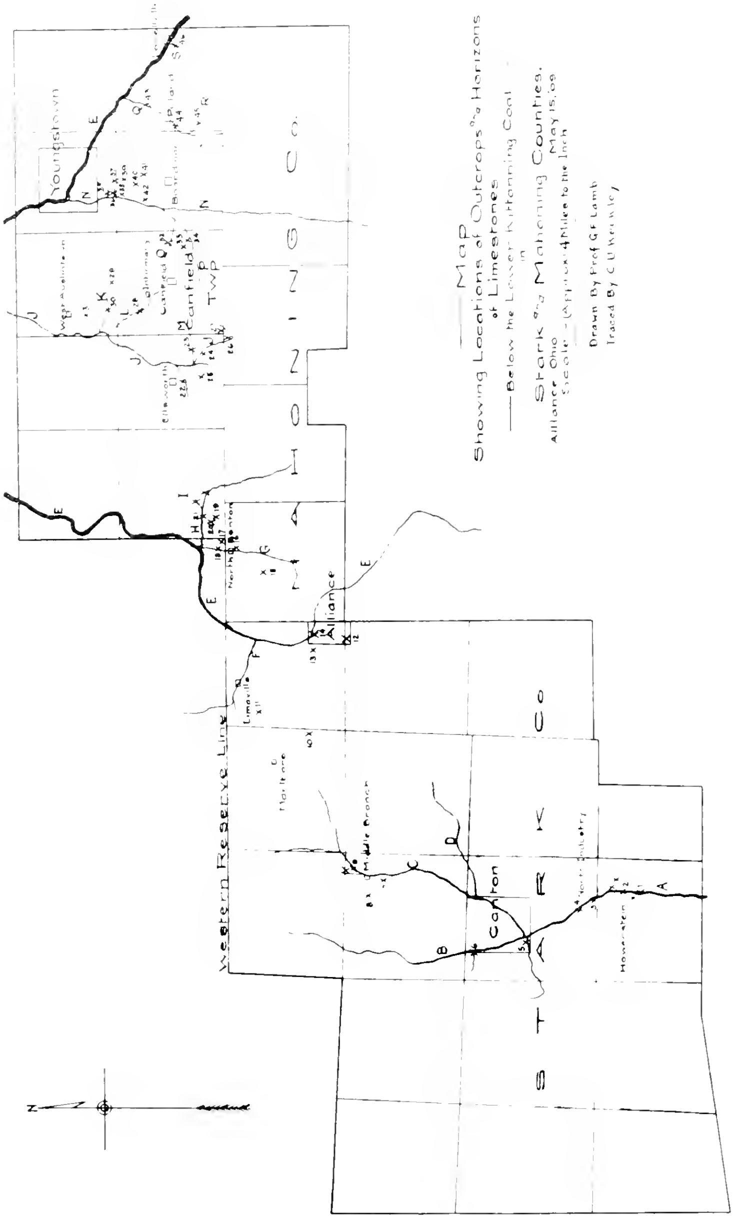
KEY TO ACCOMPANYING MAP.

The streams, cities and villages, and points of outcrop or place of occurrence of limestone are fairly accurately located on the accompanying map. Those streams, towns, and outcrops mentioned in the foregoing description are for the most part, located on the map. Streams are named by letter, and points of outcrop by numbered cross.

STREAMS

A	Nimishillen Creek
B	West Branch Nimishillen
C	Middle Branch Nimishillen
D	East Branch Nimishellen
E	Mahoning River
F	Deer Creek
G	Island Creek
H	Little Mill Creek
I	Turkey Broth Creek
J	Meander Creek
K	McMahon Run
L	Infirmary Run
M	Diehl Creek
N	Mill Creek
O	Neff Run
P	Indian Creek
Q	Yellow Creek
R	Burgess Run
S	Furnace Run

OHIO NATURALIST. *Plate V.*



POINTS OF OCCURRENCE OF LIMESTONES OR THEIR HORIZONS

1	Shews' Mill Outcrop
2	Howenstein Outcrops
3	Stallman Outcrops
4	North Industry Outcrops
5	Southwest Canton Outcrops
6	Northwest Canton Outcrop
7	Worstler Outcrop
8	Werner Outcrop
9	Cement Plant Outcrops
10	Carr Outcrop
11	Lare Mine
12	Alliance Test Well No. 1
13	Ellett Outcrop
14	Alliance Test Well No. 2
15	Best's Station Outcrops
16	North Benton Outcrops
17	Henry Outcrop
18	Island Creek Mine
19	Dustman Pottery Plant
20	Hartzell Outcrop
21	Little Mill Creek Outcrops
22	Club Lake Outcrop
23	Diehl Creek Outcrop
24	Lower Outcrop
25	Bingham Outcrop
26	Unger Outcrop
27	Ewing Mine
28	Beardsley Outcrop
29	Smith Corners
30	McMahon Outcrop
31	Ripple Outcrop
32	Neff Run Outcrops
33	Swanston Mine, Cannel Coal
34	Indian Creek Outcrops
35	Faeodi Outcrop
36	Lanterman Outcrop
37	Greenhouse Hill Outcrop
38	Baldwin Outcrop
39	Davis Well
40	Moyer Spring
41	Geiger Well
42	Walters Well
43	Yellow Creek Gorge Outcrop
44	Poland Outcrops
45	Burgess Run Outcrop
46	Furnace Run Outcrops

Mount Union College.

A SUPPLEMENTARY DESCRIPTION OF CERASTIUM ARVENSE WEBBII JENNINGS.

Otto E. Jennings.

In the Ohio Naturalist, about a year ago, the writer described as new var. *Webbii* of *Cerastium arvense* L. Recently my friend, Mr. Roscoe J. Webb, of Garrettsville, Ohio, for whom the variety was named, has sent to us for further examination some excellent specimens of the plant, collected by him on June 25, 1909, at the type locality, along the gorge of the Rocky River, Cuyahoga County, Ohio. The type specimens lacked ripe pods and the original description was in that respect deficient, but in the specimens now at hand the inflorescence contains all stages from flower buds to dehisced pods and it is now possible to give a more complete description of the variety, as follows:

Cerastium arvense Webbii Jennings. Similar or somewhat taller than varieties *oblongifolium* and *villosum*, our specimens now ranging from about 3.5 to 5 dm. in height, the larger plants often decumbent for a distance of 1 dm. or more at the base, more or less densely pubsecent, especially above, where there is often much glandular pubescence. Leaves oblong-lanceolate below to ovate-lanceolate above, the latter attaining a size of 1.2 cm. wide by 6 cm. long, all sub-acute to obtuse and somewhat paler below, the leaves of the sterile shoots being somewhat smaller and varying from oblong-lanceolate to linear-elliptic, the floral bracts being similar to the sepals in shape and size, and viscid-pubescent. Cyme strict to rather widely branched at maturity; pedicels stiff, 1 to 4 cm. long, at the apex abruptly bent so that the pod becomes more or less cernuous. Sepals narrowly oval, acute to somewhat obtuse, white-scarious margined, about 2 mm. wide by 6 mm. long. Petals about 1 cm. long by 5 mm. wide, obovate, the apex emarginate to the depth of about 1.5 mm. Pods cylindric, 2.5 to 3 mm. in diameter, 1 to 1.5 cm. long, arcuate with the apex curved upwards, yellowish white, lustrous, the teeth in dehiscence erect, about 1 mm. long, narrowly acuminate. Seeds reddish-brown, flattened-globose-reniform with a very narrow sinus, quite roughly papillose, about 0.8 mm. in diameter.

This variety, as exemplified by the specimens now at hand, has the longer pods of variety *oblongifolium* with the more dense villous-pubescence of *villosum* and is almost as densely viscid-pubescent as is the typical *Cerastium vulgatum* L. In fact, it almost appears as though there might be here a case of hybridism, the intergradation being so complete.

Carnegie Museum, January, 1910.

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TABLE OF CONTENTS.

THE BACTERIAL FLORA AS A FACTOR IN THE UNPRODUCTIVENESS OF SOILS.*

ALFRED DACHNOWSKI.

The splendid contributions concerning the general relationship existing between soil micro-organisms and scientific agriculture are their own testimony as to the soundness of this position. Of these contributions the subject of nitrification is one which has received the larger share of attention from scientific men, and the literature thereon is indeed voluminous. The value of nitrogen fixation by bacteria living within the soil itself and by bacteria which develop nodules upon the roots of leguminous plants, and the consequent increase in fertility of abandoned fields is a fact with which every student of agriculture has become familiar. A role obviously less generally understood or appreciated is that of micro-organisms in rendering a field or a habitat injurious to agricultural crops. Micro-organic life in soils and the relationship of such species as friends or foes to the crop-producing capacity of soils is a line of research still before us. It is one which offers splendid opportunities for the collection of facts of great moment to the practice of agriculture, particularly in relation to the much debated question of fertilizers. It will enable a better economic utilization and conservation of soil resources.

The number of species concerned is exceedingly great. Some are aerobic, while others are anaerobic. There are present not only beneficial nitrifying bacteria upon which the formation of important, valuable chemical compounds in the soil depends, but also denitrifying, putrefactive, and pathogenic bacteria to

*Contribution from the Botanical Laboratory of Ohio State University, 53.

which most of the diseases of the soil may be attributed. The problem concerning the processes and the products of the activity of the injurious bacteria, and the correlated question of their intimate bearing upon a decreased fertility in soils, has unfortunately been limited to work of a comparatively small number of investigators. A glance through the literature of research in soil bacteriology reveals that scarcely anything has been published on the physiological effects of bacterial decomposition products upon agricultural plants.

Recent work of an experimental nature which dealt primarily with physiologically arid habitats and drought resistance in plants (Bot. Gazette **49**: 1910) has revealed to the writer that the injurious products of a bacterial soil flora accumulating in definite layers of soil are the leading factor to be considered in the sterility of certain soils, and that these products operate selectively upon invading forms striving for occupancy. The attempt which has been made to study the physiological reaction of the products formed from the activity of single, isolated species as well as the effects of the residual products due to mixtures of bacteria is briefly stated below. The data have been tabulated and are offered now in the hope that they will be of general interest, and invite other investigators to make studies similar to the one here presented. A more detailed account covering more extensive investigations will appear later.

Without going into too much detail it is sufficient here to point out the following: In the spring of 1908 an examination of bog water and bog soils which was carried on in connection with the physiological ecology of Cranberry Island at Buckeye Lake, Ohio, disclosed that the formation of methane and other gases was of bacterial origin. Agricultural plants and various other cultivated varieties which were grown on Cranberry Island for experimental purposes showed marked difficulty of absorption, soon became stunted, took on xerophilous characters, and in most cases died. Through the courtesy of Prof. Morrey of the Bacteriological Department of this University, the bacterial examination was repeated in 1909. Under Dr. Morrey's direction, Mr. W. L. Sherman, to whom much credit is due for efficient aid, prepared dilution cultures from fresh samples of bog water. The isolation of the various species was continued upon peat-agar plates and later in test-tubes containing a beef-broth-agar medium, until from the bacterial colonies which appeared upon them the pure cultures were obtained. The bacteria thus isolated were tested for their toxin producing power upon a sterilized solution of bog water and peat. A number of large flasks of a liter capacity containing the sterilized solution were inoculated with the respective pure cultures. Several flasks were left sterile to serve as controls, while others were inoculated with

a mixture of bacteria found in 1 cc. of fresh bog water. An additional test condition was arranged at the same time from the normal, untreated bog water. All flasks were then placed in an incubator for a period varying from two to four, and six weeks At such times they were then brought to the Botanical laboratory. All physiological experiments were made in duplicate series and the greatest caution was observed to reduce the dangers of contamination during the preparation of the cultures. The physiological tests were made in half-liter "Mason" jars covered with black paper and containing 500 cc. of the inoculated solution. Wheat seedlings were used for these cultures. The seeds were germinated in sterilized quartz sand until 4–5 cm. high*. They were then carefully washed in distilled water and transplanted to the cultures. Six seedlings were used in every experiment. The seedlings were individuals selected out of a large number of plants. The flat corks to which they were fastened were previously sterilized and paraffined. The cultures were then placed in the University greenhouse in situations where the conditions of temperature and diffused light were uniform. In connection with temperature and humidity readings the measurement of the evaporating power of the air was obtained using for this purpose a standardized porous cup atmometer. The growth of the plants in the various cultures was measured by transpiration relative to the control cultures; the water loss was recorded every fifth day by weighing the cultures. In all cases the experiments were extended for fifteen days. About 35 different species of bacteria have thus far been isolated from the uppermost layer of the soil (to the depth of one foot) and 21 of them have been tested physiologically. From the data at hand the following have been selected to illustrate the variation in virility of bacterial products.

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* The following method, used by the writer for some time, is found to be convenient and very valuable for sprouting wheat seeds. An enameled dish 20 cm. in diameter and 8 cm. high, the bottom of which is perforated with openings of 2 mm. is filled with sterilized quartz sand. To keep the quartz from falling through the dish is lined with filter paper, or the openings are decreased to a size allowing the needed contact with the water by repeated dipping of the dish in melted paraffin. The dish is placed upon cork supports into a large enameled iron pan, 25 x 10 cm., containing water up to the lower 2 cm. of the dish. To prevent injury to the seedlings from the accumulation of materials which the seeds exude during germination the water is changed daily. The germinator is covered with a glass-stoppered bell-jar whose stopper may readily be replaced by one of rubber with one or more holes. When the plants are of the desired height the pan is filled with water thus allowing a ready removal.

TABLE I.

TRANSPIRATION DATA FOR SOLUTIONS INOCULATED NOV. 14, 1909, WITH PURE CULTURES OF BOG BACTERIA.

Series IV	Bacteria	Transpiration in Grams				Comparative transpiration	Percentage decrease
		5th day (Dec. 16th)	10th day	15th day	Total		
	Check	9.33	42.92	66.85	119.10	100.	0.
	B. 20	8.85	41.30	44.06	94.21	79.10	20.90
	B. 22	8.30	38.15	42.90	89.35	75.02	24.98
	B. 7	8.55	31.80	42.80	83.15	69.81	30.19
	C. 3	7.15	30.90	43.95	82.00	68.85	31.15
	C. 4	7.60	29.70	44.40	81.70	68.59	31.41
Duplicates	Check	8.80	44.50	66.83	120.13	100.	0.
	B. 20	8.40	34.25	45.98	88.63	73.77	26.23
	B. 22	7.05	35.40	46.10	88.55	73.71	26.29
	B. 7	8.15	34.45	42.21	84.81	70.59	29.41
	C. 3	8.10	30.90	44.25	83.25	69.30	30.70
	C. 4	8.40	31.15	41.65	81.20	67.59	32.41
Atmometer		102 grs.	136 grs.	125 grs.			

Using the transpiration of the controls as a basis and representing it as unity the different bacterial cultures have values in the order as indicated in the last two columns of the table. These figures show conclusively that in all cases the bacteria are responsible for the proportionally diminished transpiration and growth. The transpiration values fluctuate to a considerable extent; in some cases the differences from the controls are not so very great, but in all cultures the values lie below that of the control.

The evidence derived from the duplicate series is omitted, showing, as it does, results as closely parallel as in Table I. To what extent Table II suggests the possibility that bacteriological diagnosis when correlated with physiological criteria may determine the crop-producing power of different soils need not be discussed at length. The figures speak for themselves. Several facts, however, seem to be clearly brought out in the above data. The transpiration figures of the first five days in B. 25 and B. 1 cc. indicate that the growth of the plants was considerably stimulated by the presence of the toxic bodies in the solution. Those of the last five days prove that the solution was decidedly injurious. B. 13 is worthy of note since the plants

TABLE II.

TRANSPIRATION DATA FOR SOLUTIONS INOCULATED JAN. 15, 1910, WITH PURE CULTURES OF BOG BACTERIA.

Series VII	Bacteria	Transpiration in Grams				Comparative transpiration	Percentage decrease
		5th day (Feb. 4th)	10th day	15th day	Total		
	Check	17.65	36.20	36.60	90.45	100.	0.
	Normal bog water	7.65	11.30	8.90	27.85	30.79	69.21
	B. 25	18.15	29.30	26.85	74.30	82.14	17.86
	B. 1 cc.	18.27	30.15	25.70	74.12	81.94	18.06
	B. 13	15.72	24.65	30.85	71.22	78.74	21.26
	B. 2	17.45	29.05	24.30	70.80	78.27	21.73
	B. 1	16.60	28.95	24.85	70.40	77.83	22.17
	B. 27	12.60	24.90	22.80	60.50	66.66	33.34
	B. 6	14.00	25.40	20.80	60.20	66.65	33.45
	B. 4	14.95	23.80	20.45	59.20	65.46	34.54
	B. 29	11.60	15.55	15.85	43.00	47.54	52.46
Atmometer		114 grs.	117 grs.	102 grs.			

in that solution disclose a gradually intensified power of resistance and a physiological phase marked by a greater functional activity. The maximum rate of transpiration occurred on the fifteenth day as in the control, while that of all remaining cultures appeared on the tenth day. As compared with the control the inoculated cultures, it will be observed, have reduced the transpiration quantity of wheat plants from 20% to 52%. Another matter is the degree in which individual plants vary in tolerance and resistance. When the bacteria are omitted from the sterilized solution no evidence of toxicity is noticeable for the wheat plants growing in the solution, and their variability in growth, and green and dry weight deviates but little from the common norm. But when inoculated the culture medium becomes a condition always active in stimulating or depressing normal functions. The task of securing a co-ordination between functions of absorption, transpiration, and transport becomes, indeed, a complicated one for the plants, varying greatly within the same species and with different species. The analysis of these experiments has strengthened the conviction that the best functioning plants rather than the general average represent the proper test of the possibilities of agricultural plants under the given conditions, and that adjustment to conditions is a more

noteworthy characteristic than structural deviations or acclimatization. Much economic value would attach to an extension of these experiments by determining through selection and a more detailed physiological study the cultivated forms resistant and immune to the effects of this type of soil bacteria, and the nature of the resistance.

In order to determine the ability of the micro-organisms to convert soluble proteids into amido-acids and allied products from the decomposition of proteids enough peptone was added to solutions of sterilized bog-water and peat to make an equivalent of a 1% peptone culture. After sterilization the solutions were inoculated with the bacteria indicated in Table III. The cultures were then tested physiologically at the end of a two-weeks incubation. Since the danger of contamination becomes increasingly greater with peptone cultures, the transpiration figures for only the first five days are tabulated. They are believed to be entirely consonant with the true state of affairs since the figures in the duplicate cultures appeared in every way parallel. The wheat plants had grown in each experiment for three days at the time the photographs here added were made for the writer by Prof. Schaffner.

TABLE III.

Transpiration Data for 1% Peptone Culture Solutions Inoculated Jan. 15, 1910, With Pure Cultures of Bog Bacteria.

Series IX	Number	Bacteria	Transpiration In Grams		
			5th Day (Feb. 4th)	Comparative transpiration	Percentage decrease
	6	Control	17.65	100.	0.
	7	Pep. chk	7.00	39.65	60.35
	13	B. 13	4.85	27.47	72.53
	14	B. 25	2.70	15.30	84.70
	11	B. 2	2.30	13.03	86.97
	12	B. 4	2.40	13.60	86.40
	15	B. 1 cc.	1.87	10.60	89.40

A brief inspection of the figures and the photographs suffices to show that transpiration, growth, green and dry weight of wheat plants are in this case proportionally reduced. Compared with the weekly atmometer readings it is evident that transpiration is not merely a function of absorption and of growth but also a function of the rate of evaporating power of air, that is the saturation deficiency of air. The rate of transpiration is seen to be the product of a co-ordination of factors. It is not due to any single factor but to the cumulative action of several conditions.

At the end of the experiment a chemical examination of the peptone culture solutions, made by Dr. Lyman, indicated the presence of indol, ammonia and various non-volatile products in various proportions. A marked difference was noted in the ability of the different species of bacteria to produce indol and ammonia. The highest quantity of ammonia was produced by B. 13; the least amount was recorded for B. 1 cc.—the culture solution, it will be remembered, which consisted of a mixture of the bacteria found in one cubic centimeter of fresh bog water. None of these products were found in the control (sterilized bog water and peat). It is also to be noted that neither the organic acids nor the ammonia underwent a further change and that the absence of atmorpheric air is not a limiting essential condition for the growth of the bacterial organisms. Interesting is the fact that the organisms belong for the most part to the aerobs. The mixture culture solution (B. 1 cc.) in which the percentage decrease in transpiration was as low as 90%, seems to show that it is the function of some of the bacterial organisms to do the initial work of rendering soluble the protein compounds in the soil. The process of denitrification is carried on up to a point where further decomposition is continued by other organisms. Judging from the differences in the transpiration values of the various cultures, a whole series of bacteria seems therefore to be involved to whom are due the residual products, the algebraic sum of which in part constitutes the toxicity of the habitat encountered on Cranberry Island, the formation of methane gas, and the reactions which form the basis of the process of humification.

Thus far the isolation of bacteria involved in the decomposition of carbohydrates has not been successful. Certain microorganisms have been found to possess the ability to dissolve cellulose (filter paper) in the presence of air. To what extent these forms and the anaerobs play a role in the relation of deleterious products in the soil and cultivation of crops is now under investigation.

It is not proposed to dwell upon the general aspect of this problem in this place. In a previous paper (Botanical Gazette 47: 389–405, 1909) the writer has reported that the poisonous matter injurious to plant growth is present in the agricultural soils used as filters for bog water. The retardation seen in the contaminated soils lacked the corresponding control average in dry weight of plants to an amount of 18 per cent, 3 per cent and 36 per cent. for sand, clay, and humus soils respectively. It was further shown that the absorption and retention capacity of soil for toxins became generally higher the greater the content of humus. In concluding this part of the discussion it is well to

note the extent in which the results show clearly that the retardation in growth of wheat plants is not caused by physical or chemical conditions but through the direct activity of the bacterial flora. It has long been suspected that a reciprocal relation exists between groups of soil bacteria and the plants growing upon the soil. Various writers have been able to point out that marked differences in the productive power of different soils followed the growth of wild plants, and that these differences persist for some time. It is generally concluded therefore, that the injury caused to cultivated plants by weeds or previous crops might be due to influences on the bacterial life in the soil, and in

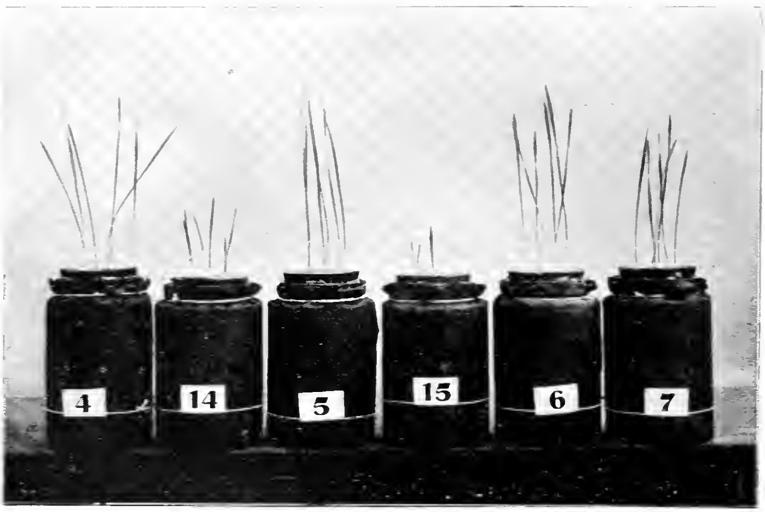


Fig. 1. Wheat plants growing in 1 per cent. peptone bog-water solutions inoculated with pure cultures of bog bacteria. Numbers correspond with data in Table III.

a direction unfavorable to succeeding agricultural crops. That such relations exist the writer is convinced in view of the evidence presented above. No doubt, the "exhaustion" of soils which is frequently met with, and which cannot always be attributed to the removal of plant nutrients, is, in part, an allied phenomenon. It cannot remain a matter of indifference to physiological ecologists whether a strong, intimate, and controlling relation exists between soil bacteria and surface flora, and how the bacterial organisms affect the character, and the association and succession of plants. At best very little is known of this phase of the physiographic process, and of the reactions and effects of the bacterial products upon plant life. It would be idle, also, to expect that the bacteriological data in themselves are sufficient for a clear interpretation of toxicity

and unproductiveness of soils. If attempted, the interpretation would be indeed, one-sided; there is a co-ordination of factors, each and all of which exert a relatively marked influence. Climatic conditions, temperature, water, and air conditions in the soil, as well as the phsycial and chemical character of it, and the surface flora, all play an important role in determining the character of a vegetation and of its bacterial flora, and therefore also the character of the chemical products formed.

One should constantly keep in mind the genetic idea in the study of edaphic, climatic, or biotic investigations. Soil, climate and flora are the product of the conditions of their development; their peculiarities are closely interrelated in the dynamics of the process. Wherever the same factors are present, the results will be similar. The bacteriological-chemical, as well as the physiological method, deserve on that account a closer consideration. The determination of the bacterial transformation products and the more detailed study of their physiological properties should possess an exactness and a reliability to make them suitable for the solution not only of agricultural but of ecological problems as well. It is only too clear that the need for new investigations in this phase of the problem is pressing, and that especially new points of view and new lines of research are imperatively required.

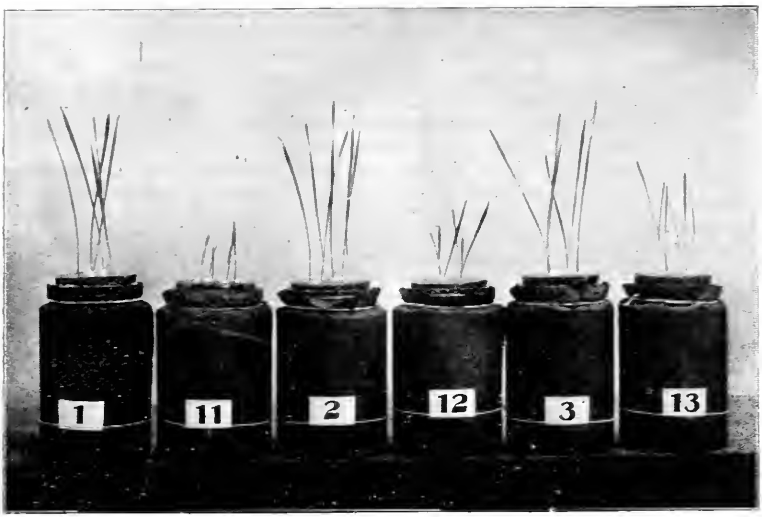


Fig. 2. Wheat plants growing in 1 per cent. peptone bog-water solutions inoculated with pure cultures of bog bacteria. Numbers correspond with data in Table III.

Botanical Laboratory, Ohio State University.

THE FILM TEST FOR CRUDE RUBBER.*

CHAS. P. FOX.

Buyers of Crude Rubber are sometimes perplexed in their efforts to determine the origin of new or uncommon varieties of rubber by their usual physical characters. Consequently an easy reliable method of determination of variety of crude rubber would be of definite value to the trade. Mr. Herbert Wright, page 163, 3rd edition of his book, HEVEA BRAZILIENSIS, in discussing the structure of crude rubber quotes the experiments of Dr. Joseph Torrey (India Rubber Journal, Nov. 1907) as follows: "Some years ago Torrey observed that petroleum naptha solution of a number of crude rubbers unwashed gave characteristic figures when a few drops were allowed to evaporate on a *white* surface. The solution consisted of 5 grams of rubber dissolved in 100 c.c. of petroleum naptha (6. p 60° to 90° c)."

"I recall that Fine Para and Matto Grosso were the two South American grades, and among the Africans were Lapori; Red Kasai, Upper Congo Ball, Ikalomba and Bussira."

Fine Para gave always a fine, lace like pattern, Matto Grosso gave a similar one, but not so fine and not so regular. Some of the Africans gave the same general type of figure but much coarser. Others deposited the rubber in a general form of one or two nebulous spots shading away very gradually towards the edges and connected by a few faint filaments, which were usually deposed between two spots in form of a coarse network the mesh being approximately circular in form.

"The most characteristic case of this kind was Lapori. On the whole the difference was so great that even an untrained observer could without difficulty, identify almost any one of the varieties under examination by its figure."

The inference to be drawn from the foregoing is that either from the method of coagulation or from some other influence a certain kind of crude rubber will give a figure peculiar to that rubber, and that this figure will serve to identify this rubber. If such be the case we have before us an easy, rapid test for determining the variety of rubber.

We gave the "test" a try out. It was soon evident that the directions given were somewhat indefinite and the original experiments lacked the earmarks of good laboratory technique.

We finally performed the test by preparing the solution of given concentration and using the ordinary microscope slide for the film receptacle. We used special care in preparing the solution. In many cases it was necessary to use a small spoon

* Presented at the Nov. meeting of the Ohio Acad. of Sci.

in transferring from container to slide. The term "figure" is rather indefinite. In the experiment quoted it is not made clear whether shape or color or character of film is to determine. We assumed that a combination of both character of film and its color was to be used. Shape of film is mere matter of accident. Draft of air, declivity of table, skill of the operator, all help to modify shape.

"The viscosity of the solution will determine the thickness of the film and will control the size, shape and number of vesicles. The most important factors to be reckoned with are colour and dirt (suspended matter)."

We made the test very thorough, and examined in all, about twenty-five kinds of crude rubber. Each test was made in duplicate. The dry film was held for a moment in the fumes of sulphur chlorid. This treatment did not alter the film but removed the tackiness. Slides prepared in this way keep indefinitely, do not stick together and are free from dust. In this way definite comparisons between a large number of films could be easily and quickly made.

We found that it was not a difficult matter to obtain similar duplicates from the same solution when made at same time. Exactness was an impossibility. In some cases the difference between duplicates were great enough to assign different names to the same samples. We used much care in getting authentic samples and in each case have compared the crude physical characters with the descriptions given by reliable authorities: Pearson, Brandt, Falconette, and Clouth.

Throughout the entire work we could not definitely determine a film peculiar to any one brand of crude rubber. Considerable stress was put upon the "Lapori film." We found this figure to be common to many kinds of rubber. Rubbers of different botanical and geographical origin often gave this same type of film.

Throughout the experiment there was an indication that the character of the film was determined by the viscosity of the solution. To test out this idea we made up a series of solutions of these rubbers, varying from thin to very thick.

The table proves the point in question. It clearly shows the influence of viscosity:

TABLE

Concentration	Kind of Rubber		
Grams	Para Tribe	African Tribe	Castilloa Tribe.
Grams in 100 cc.	Ceylon Black. Film given.	Mongalla. Film given.	Conche Ball. Film given.
" 1.25 cc.	Greasespot film.	Greasespot film.	Network film.
" 2.50 "	Network film. Faintly.	Network film. Faintly.	Wafer film. Thin.
" 5.00 "	Network film. Plain.	Network film. Destinct.	Wafer film. Heavy.
" 10. "	Wafer film. Vesicles.	Wafer film.	Wafer film. Heavy vesicles.
" 20. "	Honey Comb Film.	Wafer film. Vesicles.	Honey Comb Film.

After a close examination and comparison of the films given, in duplicate, by samples representing thirty-three commercial brands of crude rubber belonging to ten distinct groups, we fail to find any indication pointing towards a definite film peculiar to any particular brand of rubber.

Viscosity seems to be the controlling factor in the formation of a film. Viscosity depends a great deal upon the amount and freshness of the rubber content. With a crude unwashed and dirty rubber, the amount of the rubber will vary, the viscosity will be influenced and the character of the film will be modified according to the purity of the sample.

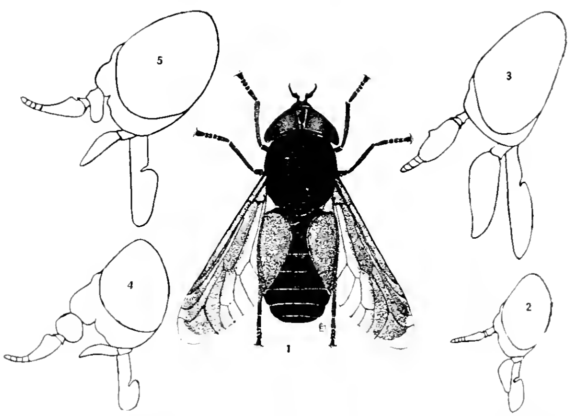
Tenacious heavy Para solution gave the honey comb film. Lapori (old) gave a thin transparent film. By adding more rubber to the latter and by diluting the former with solvent, we were able to transpose the character of the films.

Akron, Ohio, November 2, 1909.

A COMPARATIVE STUDY OF FOUR GENERA OF HORSEFLIES

James S. Hine

The dipterous family Tabanidae contains a number of genera which are not well known on account of the scarcity of material in the museums of the country. A group of four American genera which are nearly related in some respects and which have not been studied in a comparative way are known as Lepidoselaga, Selasoma, Bolbodimyia and Snowiellus. As I have the typical species of all of these genera I have selected about a dozen points upon which to make comparison and a brief statement of the results is offered for the purpose of extending acquaintance with these rather extraordinary members of our American fauna.



1, Female of Snowiellus atratus, enlarged two diameters; 2, side view of the head of Lepidoselaga lepidota; 3, same of Selasoma tibiale; 4, same of Bolbodimyia bicolor; 5, same of Snowiellus atratus.

The species of all these genera agree in having the wings largely black, the body wholly black, subcalius denuded, proboscis short and fleshy, third segment of the antenna composed of five annuli of which the basal is plainly longer than the others taken together, anterior tibia distinctly enlarged, hind tibia ciliate and the anal cell closed and petiolate. Although there are several characters common to all many differences exist and these are best pointed out by considering each genus separately.

Lepidoselaga. Type species L. lepidota from Central and South America. Length about seven millimeters, body shining black with sparse green-reflecting scale-like hairs. The genus was first called Lepiselaga by Macquart in 1838 and later emended by Loew, according to Osten Sacken. Hadrus of Perty,

1834, is a synonym but cannot be used here because of its selection as a name for a genus of Coleoptera a year earlier. Front rather wide, sides altogether parallel; frontal callosity small, narrower than the front and without an extension above; palpi flat shining black rather large and nearly spoon-shaped; face everywhere naked and shining black; under side of the head black and sparsely furnished with pale yellow hairs; antennae entirely yellow, slender throughout, third segment with a very slight basal prominence, so slight in fact that it may be said to be absent without being far wrong; legs clear black except the tarsi which are largely white; front tibia very much enlarged, middle tibia smaller but still distinctly enlarged, hind tibia ciliate and very slightly thicker than its femur; sides of the thorax black with light brown hair; wing largely black, this color extending on the costal side to the tip of the first vein and limited outwardly by a rather irregular curved line from thence to the posterior margin of the wing at the vein separated the third and fourth posterior cells, fourth and fifth posterior and anal and axillary cells largely nearly hyaline, black or the wing enclosing seven more or less rounded small hyaline spots.

Selasoma. Type species S. tibiale from South America. Length about 14 millimeters, body shining blue-black, form robust. The genus was erected by Macquart in 1838 to receive Tabanus tibialis Fabr. Front narrow, sides clearly parallel; frontal callosity small, not so wide as the front and with a distinct extension above reaching nearly to the vertex; palpi large, thickened, reaching nearly to the end of the proboscis; face black, thinly clothed with gray dust; under side of the head clothed with black hair; antennae not inserted on a prominence, black, first and second segments small, third segment compressed, rather wide and thin and the prominence which usually is near the base here is located near the middle of the length; legs entirely black and clothed with black hair, all the tibiae distinctly enlarged but with a gradual decrease in size from before backwards; sides of the thorax black with black hair; black color of the wing extending on the costal border to the tip of the auxiliary vein and limited outwardly by a line drawn nearly straight backward from this point through the middle of the discal cell to the apex of the apical cell; the cells on the posterior part of the wing are lighter in color and there is a distinct transverse hyaline spot across the fourth vein before the base of the discal cell.

Bolbodimyia. Type and only species of the genus B. bicolor from South America. Length about 11 millimeters, body opaque black, form rather slender. The genus was erected by Bigot in 1892 and described from a single specimen. So far as I am aware only three specimens of the species have found their way

into collections. Front of normal width, sides very nearly parallel although just slightly narrowed above; frontal callosity large, as wide as the front and with an extension above; palpi small, not distinctly compressed, much shorter than the proboscis; face densely clothed with orange colored pollen; under side of the head colored like the face and clothed with hair of the same color; antennae situated on a very decided shining black bulb-like prominence, first segment very large, spherical, shining black and with some black hairs on the under side, second and third segments yellowish-brown, the latter with a distinct prominence very close to the base; sides of the thorax very densely clothed with orange colored hair; legs black, front tibia enlarged and curved, distinctly larger than its femur, middle tibia plainly larger than its femur, hind tibia and femur of nearly the same size; wing black except the tip of the second submarginal cell which is hyaline, the outer limit of the black extends almost straight backwards from the tip of the anterior branch of the third vein.

Snowiellus. Type species S. atratus from Arizona. Length about 14 millimeters, body black, nearly opaque, form robust. The genus was proposed by myself in 1904 and described after having studied two specimens, the only ones I have seen. Front wide, narrowed above; frontal callosity wide, as wide as the front and with a connected spot above; palpi rather long but somewhat slender, decidedly shorter than the proboscis; antennae situated on a shining black elevation, first segment black and clothed below with black hair, produced downward but not widened or produced upward so that from above these organs appear perfectly normal, second and third segments opaque brown, the latter with a distinct prominence very close to the base; face mostly shining black; underside of the head clothed with black hair; sides of the thorax black and clothed with black hair; legs black, anterior tibia slightly enlarged, middle tibia less enlarged, hind tibia only very slightly larger than its femur; wing black with the exception of a hyaline area which curves around the apex, occupying the apexes of the first and second submarginal cells so that the outer limit of the black is marked by a curved line from the apex of the second vein to the apex of the posterior branch of the third vein.

MEETINGS OF THE BIOLOGICAL CLUB.

Orton Hall, Dec. 6, 1909.

In the absence of the President, Mr. W. C. Morse, the meeting was called to order by the Vice-President, Miss Emily Hollister. The minutes of the two previous meetings were read and approved. Prof. W. M. Barrows, Mr. T. W. Ditto, and Mr. Bentley F. Fulton were elected to membership.

The program of the evening consisted of an informal talk by Prof. G. W. Knight upon the Darwin Centenary Celebrations, held at Cambridge, England, at which he represented the University. Prof. Knight gave some account of the history, and organization of Cambridge University, and told of the ceremonies and festivities connected with the centenary celebrations. He exhibited souvenirs of the occasion, and presented the Biological Club with a very interesting picture of the delegates. Prof. Landacre moved that the Club extend its thanks for the gift of the picture and that the Executive Committee be instructed to see to the framing and hanging of it. Motion carried.

Prof. Landacre and Prof. Schaffner gave brief reports of the Ohio Academy of Science Meeting.

Orton Hall, Feb. 7, 1910.

The Club was called to order by the President, Mr. W. C. Morse, and the minutes of the previous meeting were read, and approved.

Mr. Harry Marsh and Phillip Luginbill were elected to membership, and the names of Mr. T. M. Thompson, George T. Caldwell, V. L. Nelson, and W. C. Lasseter were proposed.

Prof. W. C. Mills then spoke to the Club upon "Some Recent Explorations of the Ohio Historical and Archaeological Society." He spoke of the archaeological map of the state which is being prepared by the society and gave an account of the two ancient cultures found in the state, and the methods of exploring their remains.

Reports of the meetings of the American Association for the Advancement of Science were given by Professors Landacre, Osborn, Mills, Seymour, and Morse.

Malcolm G. Dickey, *Sec.*

Date of Publication, April 2, 1910.

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A NEW SPECIES OF CELITHEMIS (ORDER ODONATA).

E. B. WILLIAMSON.

While calling on Professor Hine at the Ohio State University last autumn he showed me 4 specimens of *Celithemis* collected by himself at Slidell, Louisiana, July 2–6, 1905. The species was unknown to both of us, and he very generously turned the material over to me for study. This study had not progressed far when it became evident that the real difficulty would lie in determining which of two species Kirby had before him when he described his *Celithemis fasciata*, to which species numerous specimens from Ohio and Indiana collected by Kellicott and his students and co-laborers had been referred. In working out the differences between the northern (Ohio and Indiana) specimens and those from Louisiana, however, it became clear that the name *fasciata* would have to go to the southern species, and that the better known northern species required a new name. I informed Professor Hine of this and he kindly requested me to complete the study and send him the paper for the OHIO NATURALIST.

Reasons for assigning Kirby's name *fasciata* to the Louisiana specimens and describing the Ohio and Indiana specimens, formerly called *fasciata*, as a new species, *monomelaena:*

1 and 2. In Kirby's description he says: "Triangle (front wing) crossed by one or two nervures, followed by 4 rows of cells." His figure shows the triangle with 2 crossveins and 4 posttrigonal cells on each side. (It is possible that the venation shown in the figure has one side duplicated on the opposite side by the artist.) Referring now to these characters in the material before me I find that the 4 Louisiana specimens (*fasciata*) have 5 front wings with 2 crossveins and 3 wings with 1 crossvein in the triangle,

while of 16 wings of *monomelaena* examined only a single wing has 2 crossveins, all the others having but 1. Also, 6 wings of *fasciata* have 4 posttrigonal cells, and 2 wings have 5. On the other hand 9 wings of *monomelaena* have but 3 cells, although 7 wings have 4.

3. Kirby's figure shows the first row of cells, proximal to the postanal cell, between A and posterior margin of wing in front wing as 3 cells wide. In the Louisiana specimens this is true for 7 wings, while 1 wing has 2 cells; in 16 wings of *monomelaena* examined these are invariably 2 cells. (Kirby figures the postanal as a single cell. This is undoubtedly an error. My material shows it 2 or 3 celled.)

4. Kirby mentions the enclosed basal pale area in the hind wing as being yellowish or yellow, though his figure does not show this. The accompanying half tones show this character clearly in the Louisiana specimens. It is entirely lacking in *monomelaena*, whence the specific name.

5. In *fasciata* as described and figured the colored area just proximal and posterior to the nodus in the front wing extends posteriorly across Cu_1. This is true of all the Louisiana specimens. In *monomelaena* on the other hand this dark area in its maximum development is limited posteriorly by the median supplement.

So much for the identification of *fasciata*. Other characters point to the specific distinctness of *monomelaena* and *fasciata*, though unfortunately I am unable to find such characters elsewhere than in the wings. Two venational characters are of interest: the number of cells between A_2 and A_3 in the hind wing and the number of cells on the posterior margin of the hind wing from the base of the wing to the anal loop. In both of these characters *fasciata* has a greater number of cells than *monomelaena*, and in both species in the case of the first character the female has more cells than the male, while in the second character the male has more cells than the female. These characters may be tabulated:

Number of cells between A_2 and A_3 in hind wing:

fasciata male, one wing 11, two 12, one 14; average 12.25.
female, three wings 15, one 17; average 15.5.

monomelaena male, three wings 9, two 10; average 9.4.
female, two wings 9, four 10, two 11, one 12, one 13; average 10.5.

Number of cells on posterior margin of hind wing from the base of the wing to the anal loop:

fasciata male, one wing 32, two 34, one 35; average 33.75.
female, two wings 31, two 33; average 32.

monomelaena male, one wing 24, two 25, one 26, one 27; average 25.4.
female, one wing 21, one 23, two 24, one 25, two 26; average 24.14.

Of 8 wings of *fasciata* and 16 wings of *monomelaena* examined all have the last antenodal of the front wing continuous, excepting one wing of each species. All have the triangle of the hind wing free excepting a single wing of *fasciata*, where it is once crossed.

CELITHEMIS MONOMELAENA n. sp.

Celithemis fasciata, Hine, in THE ODONATA OF OHIO, D. S. Kellicott, O. S. U., UNIV. BULL. SERIES 4, NO. 5, p. 104, describes the species and records its capture in Summit County, Ohio, at Silver and Summit Lakes, in June and July, June 23rd being the earliest record. Hine, ENT. NEWS, January, 1899, p. 1, describes the female, with figures of wing markings of both sexes, and notes habits and records of captures. Williamson, REPORT STATE GEOLOGIST, INDIANA, 1899, p. 320, describes the species and records it from the following Indiana localities: Goose Lake, Kosciusko County, Round and Shriner Lakes, Whitley County, and Frantz Fishpond, Wells County.

The above literature, with the notes given above and the plates which accompany this paper, sufficiently describes this species. The following references under *fasciata* should be placed under *monomelaena*, I believe.

1. Hagen, PSYCHE, 1890, p. 383, records *fasciata* from Georgia, Florida and Canada. The Canadian specimen is probably *monomelaena*, the other two *fasciata*.

2. Kellicott, PROC. OHIO ACAD. SCI., 1896, p. 28, records the capture of *fasciata* by Dury at Cincinnati and Williamson in Indiana.

3. Kellicott, THE AGR. STUDENT, Columbus, Ohio, Nov., 1897, p. 45, repeats the data in 2.

4. Williamson, REPORT STATE GEOLOGIST, INDIANA, 1897, p. 404, records *fasciata* for Shriner Lake, Whitley County, Indiana.

5. Williamson, ENT. NEWS, 1899, p. 42, notes on pairing of *fasciata* at Round Lake, Whitley County, Indiana, during July, 1898.

6. Hine, PROC. OHIO ACAD. SCI., 1899, p. 67, records *fasciata* from Silver Lake, Akron, Ohio, June 23rd.

7. Osborn and Hine, O. S. U. (OHIO) NATURALIST, 1900, p. 15, record the capture of about 30 specimens at lakes near Kent, Ohio, in the latter half of June.

8. In ENT. NEWS, 1902, p. 298, Mr. E. Daecke's capture of *fasciata* at Lucaston, New Jersey, is recorded.

9. Calvert, Ent. News, 1903, p. 36, records *fasciata* for Lucaston, New Jersey, June 22, July 2, 1900–2, collected by E. Daecke.
10. In Ent. News, 1907, p. 456, Mr. Laurent's capture of *fasciata* at Malaga, New Jersey, July 20, is recorded.
11. Muttkowski, Bull. Wis. Nat. Hist. Soc., Vol. 6, 1908, p. 108, describes *fasciata* and records it from Milwaukee County, Wisconsin.

Celithemis fasciata Kirby.

Trans. Zool. Soc. Lond., XII, 1889, p. 326, pl. LII, fig. 2.

As above stated Hagen's reference to *fasciata* from Florida probably refers to this species. In Ent. News, 1906, p. 84. C. S. Brimley records *fasciata* from Lake Ellis, North Carolina, June 22nd. This probably refers to true *fasciata*.

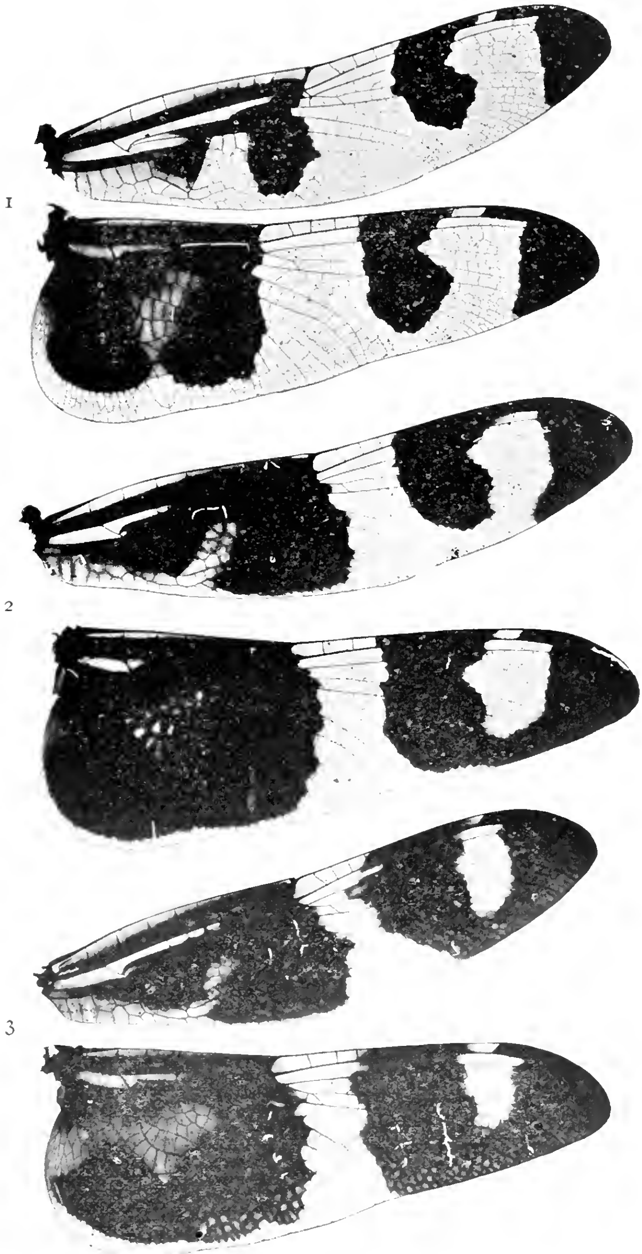
Soon after beginning this study I wrote to Mr. Dury about his Cincinnati record. He sent me a water color sketch of his specimen, taken in 1895. It is certainly *monomelaena*. It was taken at a small lake in Spring Grove Cemetery. Several were seen but only one was captured and he has not seen the species since. He does not know who is responsible for determining his specimen as *fasciata*, but I recall from conversations with Professor Kellicott that he was not the authority, and my Indiana specimens were named *fasciata* for me by Kellicott after he or Hine had seen Dury's specimen bearing this label.

Dury's experience with the species at Cincinnati is similar to mine in Wells County. It was taken at Frantz Fishpond (a deserted gravel pit) in 1898 and again in 1901, but I have been unable to find it there since. I have not seen the species alive since 1904 when it was taken in Steuben County, Indiana.

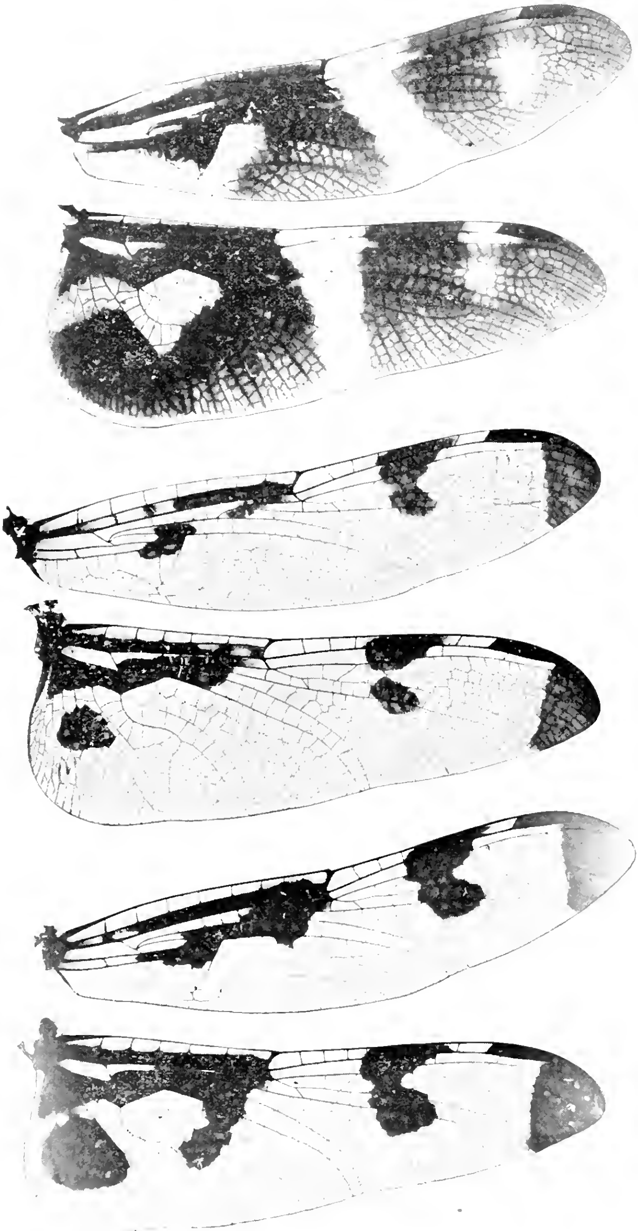
My thanks are due Professor Hine for delegating to me this work in an order of insects in which he himself is greatly interested. Professor J. B. Parker has on this occasion, as on others, given me the benefit of his knowledge of Greek, and the specific name *monomelaena* is of his compounding. The photographs of wings, from which the plates have been made, were taken by Professor Newton Miller, Clark College.

The types of *monomelaena* are a male and female, Whitley County, Indiana, in my collection.

Bluffton, Indiana.



WILLIAMSON on "Celithemis."



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Williamson on "Celithemis."

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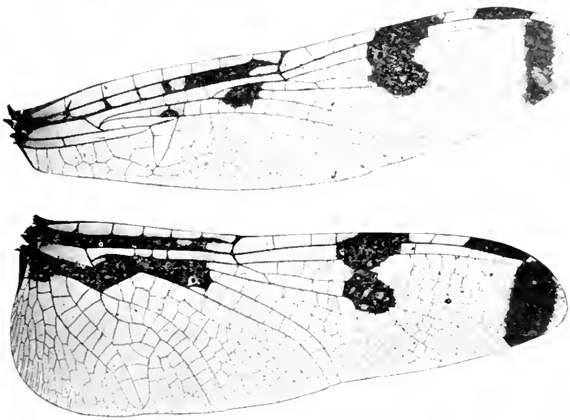

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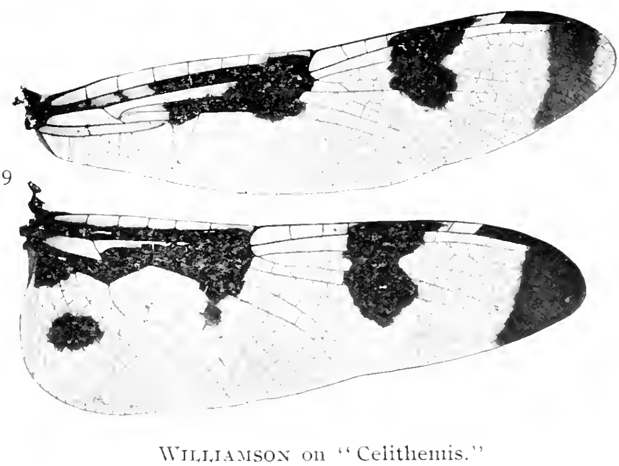

Williamson on "Celithemis."

EXPLANATION OF PLATES VI, VII, AND VIII.

Figs. 1, 2, males, 3, 4, females, *Celithemis fasciata* Kirby, all from Slidell, Louisiana, July 2, 1905, J. S. Hine.

Figs. 5, 6, males, 7, 8, 9, females, *Celithemis monomelaena* new species, all from Whitley County, Indiana, excepting 6 from Kent, Ohio, J. S. Hine. 7 is the type ♀ of *monomelaena*. 5, 8 and 9 are teneral specimens.

Wings of *monomelaena* have been selected to show the extremes of variation in wing markings. Notice wing apices in 7, 8 and 9, and notice hind wings in these 3 figures showing that a great development of one colored area is not necessarily associated with other greatly developed areas in the same wing. In Figures 1 and 2 the enclosed pale basal area in the hind wing is open to the wing border proximally as in Figures 3 and 4, but the orange color of the pale area is so intense as to obscure this in the photographs. Notice that in *fasciata* this pale area is always open to the border proximally, and is closed or tends to close across the posterior end of the anal loop (nearly closed in Figure 1, completely closed in 2, 3 and 4); *monomelaena*, on the other hand, tends to close proximally (see Fig. 6) and remains open posteriorly across the anal loop. There is in the behavior of these colored parts two distinct tendencies in the two species (compare these areas in Figures 4 and 6).

TWENTY-FIVE RARE PLANTS AT BARNESVILLE, OHIO.

EMMA E. LAUGHLIN.

Every locality has its plants which are found in great profusion, and also those which are rare, although they may be the common plants in another region. To the botanist it is always a special pleasure to find the retreat of some rare local species. Below are noted twenty-five plants which may be regarded as locally rare within a circle having a radius of four miles with Barnesville, Belmont County, as a center. A more careful study of the region might show some of the species more common than they are now supposed to be.

1. **Viola rafinesquii** Greene. One station was found for this violet in 1908. It is in a railroad cut east of Barnesville. The plants are increasing rapidly from seeds. They grow well when transplanted.

2. **Viola blanda** Willd. This violet was also first found in 1908 in a deep shady ravine through which a small stream creeps. It is most abundant at the end of the ravine where a tiny swampy flood plain has been formed.

3. **Viola hastata** Michx. One station discovered in 1907 in a dense wood. Its location has been revealed to only three people so that the plants may be allowed to increase. It is probable that other stations may be found as this violet is not rare in the adjoining county. Ten other violets may be regarded as common in this locality.

4. **Cubelium concolor** (Forst.) Raf. One station was discovered for the green violet in 1903. It was on a clay bank in a dense wood and has increased but little in size. Since then two other stations have been found, one of them in a bright sunny spot on the roadside.

5. **Barbarea praecox** (J. E. Smith) R. Br. First noticed by the writer in 1902 in a pasture field when only a few plants, not over six inches in height, were seen. Each year since, more plants have been found until 1909 when it could no longer be called rare. It is a plant of the pasture fields. It is usually called mustard because it resembles somewhat the black mustard as to the color of the flowers. The early winter cress blooms from ten days to two weeks before Barbarea barbarea (L.) MacM. It is a perennial but blooms the first year.

6. **Synandra hispidula** (Michx.) Britton. Found first in a ravine on the edge of a wood in 1902. Only one station. It is most abundant in alternate years and is biennial. The station was partly destroyed in 1909 when one side of the ravine was cleared.

7. **Chaerophyllum procumbens** (L.) Crantz. First seen in 1907 in an open thicket on a south hillside, peeping out from beneath an aged wild gooseberry bush. While it produces many seeds, it does not seem to spread very much.

8. **Quamasia hyacinthina** (Raf.) Britton. Also found in 1907. Station in a swampy place in a meadow. Plants very strong and thrifty.

9. **Triosteum perfoliatum** L. Found along a fence between a road and a pasture field. One station. Plants spreading rapidly. May be found elsewhere within our region as it is common just over the line in Guernsey County.

10. **Potentilla pumila** Poir. Found occasionally in pasture fields, usually in poor soil. Does not seem to spread.

11. **Potentilla recta** L. Found in a pasture field on a high hill. About a dozen plants seen in 1908 but not seen in 1909. The plants were vigorous and well-developed.

12. **Silene virginica** L. Found occasionally in an open thicket. Though a perennial it does not seem to spread rapidly.

13. **Silene stellata** (L.) Ait. Abundant in one station—a wood which has never been pastured or cleared out in any way. Many rocks are found there, some of them lying just beneath the surface of the ground. Over these rocks this campion grows plentifully. It can be transplanted easily.

14. **Silene noctiflora** L. Not common with us as it seemed to be near Wooster, O. One station only observed. This is on the roadside just outside of a garden, and was first noticed by the writer in 1902.

15. **Smilax herbacea** L. Found in an open situation near a small brook in 1904. One plant was transplanted in a wild flower garden and has appeared with increased vigor every year since. As this is a staminate plant, there have been no berries.

16. **Panax quinquefolium** L. Now rare in this region, but it was once abundant. It is disappearing for two reasons: First, because the rich woods it loves are disappearing; second, because its commercial value invites hunters to dig it up for the roots.

17. **Arenaria serpyllifolia** L. This little sandwort is found occasionally growing in the cinders by the railroad tracks and spreads rapidly if circumstances are at all favorable.

18. **Dioscorea villosa** L. Said to be found in moist thickets, but one station is known for staminate plants which is on a dry hillside. It is spreading slowly from the woody rootstocks. It is easily transplanted.

19. **Verbena stricta** Vent. One plant was found in 1908 on the public school grounds, almost in a footpath. It was thrifty and strong in 1909, and had added a stem to the three seen the year before. V. urticifolia L. is very common in cultivated ground, and V. hastata L. occurs in damp situations.

20. **Galinsoga parviflora** Cav. Found growing in one back yard on Walnut Street, Barnesville, Ohio. Its presence is accounted for by the fact that the family living there moved from Washington, Ohio, where Galinsoga is very abundant, growing along the gutters at the sides of the streets or anywhere it can get a start.

21. **Agastache scrophulariaefolius** (Willd.) Kuntze. Although A. nepetoides (L.) Kuntze is common, being found in any locality, A. scrophulariaefolius (Willd.) Kuntze is rare, only one station having been observed. This is a marshy place by the roadside and was almost exterminated in 1909 by the road supervisor.

22. **Matricaria inodora** L. One plant was found in 1909, about ten rods from the chaerophyllum station. It was evidently a stray.

23. **Polygonum arifolium** L. One station, a low place in a pasture field. Its rarity has always been a matter of surprise since P. sagittatum L. is very common.

24. **Hieracium aurantiacum** L. Has been observed along one roadside in well-set grass. Late in the season it is stoloniferous and forms a little colony around each plant.

25. **Sida spinosa** L. First seen by the railroad. Last year discovered in a meadow in abundance after the second cutting of clover had been made. Evidently the seed had been sown with the grass seed.

Barnesville, Ohio.

NOTES ON THE NESTING HABITS OF BEMBEX NUBILIPENNIS.

By J. B. Parker.

While engaged in field work at Wilson, Kansas, in August, 1909, I chanced upon the nesting site of a large solitary wasp that proved to be Bembex nubilipennis. The wasps of this species, known in that locality as "yellow jackets," are handsome insects, exceedingly fast on the wing and alert, nervous and cautious when about their nests. Though they are solitary wasps they nest in colonies and the nesting site under observation was in a driveway leading from the public road into a barnyard, where the earth in which the nests were placed was trampled so hard that much difficulty was experienced in opening them. The owner of the place stated that these wasps had nested there annually for a number of years and his statement was borne out by the number of old burrows discovered during the investigation.

The burrows, penetrating to a depth of six or eight inches, enter the ground at an angle of about forty-five degrees; but there is no very great uniformity in this respect. At a distance of from eight to twelve inches from the entrance lateral branches are given off, which serve as brood chambers for the larvae. At the time of my observation no burrow was found with more than five of these chambers; most had four and a few had only three. In the chambers more than one larva may be reared, in which case the first is placed at the extreme end of the chamber and when full grown and encased a wall is placed across the chamber and another larva reared between this and the main part of the burrow.

The wasp in digging uses the first pair of legs, turning the tarsi inward so as to make a pair of rakes out of the stout spines borne on the posterior sides of these segments. At that time the dust of the surface of the driveway lay about an inch deep and the horses in passing back and forth over the nests completely changed the appearance of the surface several times a day. But this did not seem to bother the wasps a great deal, for they almost invariably digged down through the dust directly to the mouth of a burrow. The burrow thus found, however, did not always prove to be the one desired; in fact, one wasp was observed to dig into three different burrows before she found the one she sought. Whether the first two opened were hers also or the property of another wasp I had no means of finding out in the brief time at my command. On leaving the nest the wasp not only closes up the entrance but also carefully conceals all traces of it, so carefully, indeed, that she has quite as much trouble at times in finding the entrance as she does when the horses have

disturbed appearances. Whenever the nest is entered the opening is likewise always closed up from the inside.

These observations were made on August 18 and 19, and although many burrows were opened only larvae were found. Many of these had completed their growth and were encased in cells of earth held together by some cement substance and lined inside with delicate silk; but in every instance an immature larva in some stage of development was also found in the burrow. In no case, however, was more than one developing larva found in any burrow. In one burrow with four branches there contained matured and encased larvae and the fourth, just newly constructed, contained two recently killed house-flies, on one of which was found an unhatched egg. From the data given above it would appear that the wasp rears only one larva at a time, unless perchance she constructs and attends two or more burrows at the same time, the necessity for which is not apparent.

The food of the larva, as shown by the nests opened, consists wholly of flies and it seems that certain females show a preference for a particular kind of fly. In one nest only house-flies were found; in a second the majority were stable-flies; in a third, flesh-flies; in a fourth, tachina-flies. The wings, legs and usually the thorax of the fly are not consumed by the larval wasp. The remains of forty-one flies, of which most, perhaps all, were house-flies, were taken from a chamber containing an almost mature larva, and doubtless these were not the total number of flies consumed by this individual. In the evening from a chamber containing a half-grown larva ten untouched flies were taken, among which were represented the following species kindly identified for me by Prof. J. S. Hine: Euphorocera claripennis, Pseudopyrelia cornicina, Sarcophaga assidua, and Sarcophaga helicis.

According to my limited observations all burrows containing immature larvae are closed up at nightfall with the female inside the nest. The popular belief is that the male closes up the burrow from without after the female has entered the nest for the night, but I saw nothing that would tend to confirm this opinion. The lad that helped me to open the burrows stated that he had often drowned the wasps out of their nests and that he usually chased two out of each nest. From the manner in which he described the proceedings I fear the fun he got out of the operation is more worthy of credence than is the accuracy of his observations, for in no instance did I get more than one wasp from a burrow and all thus taken were females. Unfortunately, I had no net with me and hence was unable to determine whether any males were among the numbers that were continually darting about over the nesting site, though I suspect that such was the case.

A small species of fly, presumable a tachinid, was observed very active about the entrances to the burrows, and it was amusing to watch these little rascals, one or more of which were usually on hand whenever a burrow was being opened. The wasp seems very nervous when opening her nest, frequently pausing in her task to run hither and thither about the half-opened entrance or to rise on the wing and buzz around at varying distances from it. But no matter what the circumstances were the little fly always faced the wasp, seeming to realize that its safety lay in its vigilance; and the rapidity with which it would face about or dart from side to side as the wasp moved about it, left little room to doubt that it was up to some sort of mischief. If the wasp moved away from the opening to any great distance the fly would dash into the burrow and in an instant pop out again at a lively pace; but in the instances observed the fly accomplished nothing by its bold dashes, for the wasp had not opened the burrow deep enough to permit the fly to reach the brood chamber. Frequently as the wasp entered her nest one, and sometimes several, of these flies would dash into the entrance behind her, only to have their eyes flung full of dirt by the cautious wasp as she closed up the opening from within.

Just what business these little rascals had in the burrow I failed to make out. Perhaps they sought to parasitize the larva of the wasp or perhaps to place their eggs upon the food provided for it. I found no evidence of parasitism but in two instances I found small larvae of some sort feeding on the flies in a chamber containing an immature larval wasp. That enemies are feared by the wasp seems evident from the fact that the entrance to the nest is never left open even when the wasp is inside it.

One man complained of these wasps, insisting that they stung his horses when at work in the fields. But the presence of large numbers of stable-flies in the brood chambers shows that the wasp is a friend of the horse, not an enemy as my friend had supposed. The fact that they attack the housefly is also much to their credit, but the presence of tachina-flies among the food of the larvae indicates that their habit of preying on flies is not wholly commendable. The extent of my investigation, however, was too limited to permit me to hazard an opinion as to their economic position.

THE OHIO POWDERY MILDEWS.*

W. C. O'Kane.

Introduction.

A number of years ago Professor A. D. Selby published a paper on The Ohio *Erysiphaceae*, or Powdery Mildews, so far as they had been reported in this state at that time.

Since then new species have been recorded, new host plants have been reported, and there have been changes in nomenclature as further scientific study has disclosed certain synonyms.

The present paper is an attempt to bring the record down to date.

In the generic keys as well as the specific descriptions the writer has closely followed Salmon's admirable monograph of the *Erysiphaceae*.

Acknowledgment is due the valuable assistance of Professor J. H. Schaffner, under whose direction this paper has been prepared; also the suggestions and counsel of the late Dr. W. A. Kellerman.

General Characteristics of the Powdery Mildews.

The Powdery Mildews are familiar to observers in two distinct stages.

In the earlier, or conidial, stage, the affected parts of the parasitized plant appear as if covered with a white, mealy powder—the summer spores given off by the rapidly growing mycelium.

Later the winter spore-cases, or perithecia, are formed. These are dark, spherical bodies, distinguishable with the unaided eye, and give the affected parts of the plant the appearance of being more or less covered with a brown or black powder.

The perithecia usually bear characteristic appendages. If the perithecium is gently crushed it is found to contain one or more spore-sacs, or asci, in which are the spores. The outer surface of the perithecium is divided into many cells.

The mycelium that bears the conidia and the perithecia grows on the surface of the leaf, or stem, drawing its nourishment by means of short branches, or haustoria. These may penetrate directly into the epidermal cells; or, as in the genus *Phyllactinia*, may enter the stomata of the leaf, and so reach the inner cells. In either case the plant is robbed of its sap, and the mildew lives at the expense of its host.

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* Contribution from the Botanical Laboratory of Ohio State University, 56.

KEY TO THE GENERA (After Ellis & Everhart).

Class—ASCOMYCETAE.

Order—PERISPORIALES.

Family—ERYSIPHACEAE.

1. Appendages of perithecia simple, and similar to the mycelium......2
   Appendages different from the mycelium......................3
2. Only on ascus in the perithecium.....................*Spaerotheca*
   Several asci in the perithecium......................*Erysiphe*
3. Appendages coiled at tip............................*Uncinula*
   Appendages branched at tip..............................4
   Appendages not branched, swollen at base, with tip straight.... *Phyllactinia*
4. Only one ascus in perithecium....................*Podosphaera*
   Several asci in perithecium.......................*Microsphaera*

Sphaerotheca, Sw.

Key to the Ohio Species.

1. Mycelium thick, forming persistent patches containing the perithecia 2
   Mycelium thin or not persistent.............................3
2. Mycelium brown. Outer and inner walls of perithecium not separating.....................................*mors-uvae*
3. Perithecia 60–70 μ in diameter; ascus 60 x 42 to 70 x 50 μ, inner and outer walls of perithecium readily separating..*phytoptophila*
   Perithecia 58–120 μ in diameter; ascus 45 x 50 to 72 x 90 μ, inner and outer walls of perithecium separating with difficulty..4
4. Cells of perithecium averaging 15 μ......................*humuli*
   Cells of perithecium averaging 25 μ..........*humuli* var. *fuliginia*

Sphaerotheca humuli (DC) Burr. Perithecia 58–120μ in diameter; cells 10 to 20 μ; appendages usually long, straight, septate, dark brown; ascus usually without stalk, 45 x 50 to 72 x 90 μ; spores 8, 12 x 20 to 18 x 25 μ.

Host plants in Ohio Herbarium: Geum canadense, Medina Co., Rubus odoratus, Cuyahoga Co., E. Claassen; Rosa (cult), Columbus, J. G. Sanders; Taraxacum taraxacum, Auglaize Co., J. D. Simkins; Agrimonia eupatoria, Lancaster, W. A. Kellerman.

Sphaerotheca humuli fuliginea (Schl.) Salm. Perithecia averaging smaller than humuli; cells averaging 25 μ; spores 12 x 20–15 x 25 μ.

Host plants in Ohio Herbarium: Prenanthes alba, Cuyahoga Co., E. Claassen; Bidens frondosa, Columbus, F. L. Stevens, Cuyahoga Co., E. Claassen; Taraxacum taraxacum, Cuyahoga Co., E. Claassen, Columbus, F. L. Stevens.

Spharotheca mors-uvae (Schw.) B. & C. Mycelium dense; perithecia abundant, 75–110 μ in diameter; cells 10–25 μ; appendages few, pale, brown, tortuous, length 1–5 times diameter of perithecium; ascus 50 x 70–62 x 92 μ: spores 12 x 20–15 x 25 μ.

Common on cultivated gooseberries throughout Ohio.

Sphaerotheca phytoptophila, Kell & Swingle. Mycelium thin; perithecia 60–78 μ in diameter, inner wall separating easily; cells 10 μ, obscure; appendages few, irregular, often septate, usually longer than diameter of perithecium; ascus 42 x 60 to 50 x 75 μ; spores 8, 12 x 20–15 x 25 μ.

Host-plant, the distorted branches produced by the Phytoptus growing on Celtis occidentalis.

Specimens in the Ohio Herbarium from Preble Co., Brown Co., Mt. Gilead, W. A. Kellerman; Morgan Co., Kellerman and Jones.

Otherwise reported in Ohio from Lima, W. A. Kellerman, Columbus, A. D. Selby.

Erysiphe Hedw.

Key to the Ohio Species.

1.	Perithecia not usually maturing on living host plant....	*graminis*
	Perithecia usually maturing on living host plant................	2
2.	Asci 8-spored..................................	*polygoni*
	Asci 2-spored...	3
3.	Asci usually 10–15, haustoria lobed....................	*galeopsidis*
	Asci same, haustoria not lobed....................	*cichoracearum*

Erysiphe graminis DC. Mycelium rather persistent; perithecia large, 135–280 μ in diameter; cells obscure; appendages short, simple, light brown; asci 9–30, 70 x 25–108 x 40 μ, long-stalked; spores 8, 20 x 10–23 x 13 μ.

Host plants in Ohio Herbarium: Poa pratensis, College Hill, W. H. Aiken.

Otherwise reported in Ohio; Triticum valgare, Columbus, F. Detmers, Lima, W. A. Kellerman; Poa pratensis, Columbus, W. A. Kellerman; Agropyrum, Ashtabula Co., Sara F. Goodrich.

Erysiphe polygoni DC. Mycelium usually thin; perithecia 65–180 μ in diameter; cells 10–15 μ; appendages variable, usually many, 5–15 times diameter of perithecium, simple, sometimes flexuose; asci 2–10, 46 x 30–72 x 45 μ, sometimes with short stalk; spores 3–8, 19 x 9–25 x 14 μ.

Host plants in Ohio Herbarium: Caltha palustris, Columbus, W. A. Kellerman; Polygonum aviculare, Sandusky Co., Ottawa Co., W. A. Kellerman, Toledo, F. D. Kelsey; Polygonum sp., Miami Co., W. A. Kellerman and W. R. Beatty, Adams Co., Athens Co., W. A. Kellerman; Polygonum erectum, Franklin Co., F. L. Stevens, Belmont Co., Sugar Grove, Brown Co., W. A. Kellerman; Scutellaria laterifolia, Cuyahoga Co., E. Claassen; Oenothera biennis, Lake Co., E. Claassen; Thalictrum purpurascens, Lake Co., E. Claassen, Lupulinus perennis, Erie Co., F. L. Stevens, Toledo, F. D. Kelsey; Eupatorium sp., Columbus, C. M. Weed; Celmatis virginiana, Columbus, C. M. Weed; Aquilegia canadensis, Champaign Co., W. C. Werner.

Otherwise reported in Ohio: Aquilegia canadensis, Columbus, F. Detmers; Clematis virginiana, Columbus, A. D. Selby, F. Detmers; Clematis sp. (cult), Columbus, A. D. Selby, F. Detmers, Waynesville, W. A. Kellerman; Desmodium canescens, Columbus, A. D. Selby; Liriodendron tulipifera, Columbus, Fairfield Co., A. D. Selby.

Erysiphe galeopsidis DC. Practically the same as E. cichoracearum, except that the haustoria are larger and are lobed.

Host plants in Ohio Herbarium: Stachys sp., Columbus, W. A. Kellerman.

Otherwise reported in Ohio: Scutellaria laterifolia, Columbus, A. D. Selby, W. C. Werner, Fairfield Co., A. D. Selby; Stachys aspera glabra, Columbus, W. A. Kellerman; Stachys palustris, Columbus, A. D. Selby; Chelone glabra, Ashtabula Co., Sara F. Goodrich.

Erysiphe cichoracearum DC. Perithecia 80–140 μ in diameter; cells 10–20 μ, distinct; appendages numerous, 2–4 times the diameter of the perithecium; asci 10–15, stalked, 58 x 30–90 x 50μ; spores 2, 20 x 12–28 x 20 μ; haustoria not lobed.

Host plants in Ohio Herbarium: Helianthus tuberosus, Sandusky Co., Sugar Grove, W. A. Kellerman; Helianthus sp., Lancaster, W. A. Kellerman, Columbus, H. H. Richardson; Asclepias syriaca, Cuyahoga Co., E. Claassen; Vernonia gigantea, Portage Co., Cuyahoga Co., E. Claassen; Ambrosia trifida, Columbus, F. L. Stevens, Cuyahoga Co., E. Claassen; Aster sp., Columbus, F. L. Stevens, Amanda, W. A. Kellerman, Georgesville, E. V. Wilcox; Hydrophyllum macrophyllum, Columbus, A. Brooks, Cincinnati, W. H. Aiken; Ambrosia artemisiaefolia, Columbus, F. L. Stevens, Cuyahoga Co., E. Claassen; Aster paniculata, Vernonia fasciculata, Solidago canadensis, Verbesina alternifolia, Cuyahoga Co., E. Claassen; Verbena hastata, Cuyahoga Co., E. Claassen, Lancaster, W. A. Kellerman, Columbus, C. M. Weed; Aster laevis, Eupatorium perfoliatum, Aster novi-belgii, Cuyahoga Co., E. Claassen; Verbena urticaefolia, Cuyahoga Co., E. Claassen, Amanada, W. A. Kellerman; Phlox divaricata, Hamilton Co., W. H. Aiken; Phlox (cult) Fairfield Co., W. A. Kellerman; Actinomeris squarrosa, Columbus, C. M. Weed, Amanda, W. A. Kellerman, Toledo, F. D. Kelsey.

Otherwise reported in Ohio: Parietaria pennsylvanica, Columbus, A. D. Selby; Hydrophyllum macrophyllum, Pickaway Co., W. A. Kellerman, Fairfield Co., A. D. Selby; Dahlia (cult), Fairfield Co., W. A. Kellerman, Columbus, A. D. Selby; Helianthus sp., London, Mrs. K. D. Sharp.

Uncinula Lev.

Key to the Ohio species.

1.	Appendages colored one-half their length or more	*necator*
	Appendages colorless	2
2.	Asci 2-spored	*macrospora*
	Asci 4–8-spored	3
3.	Appendages flexuous	*flexuosa*
	Appendages straight	4
4.	Appendages thick-walled, dark or rough at base, perithecia 64–146μ in diameter, asci 34–40 μ wide	*clintoni*
	Appendages thin-walled throughout	5
5.	Asci 4–6 spored	*salicis*
	Asci 7–8 spored	*circinata*

Uncinula necator (Schw.) Burr. Perithecia scattered, 70–128 μ in diameter; cells distinct, 10–20 μ; appendages 7–32 in number, 1–4 times diameter of perithecium; simple, septate, brown in lower half; asci 4–7, sometimes short-stalked, 50 x 30–60 x 40 μ; spores, 4–7, 18 x 10–25 x 12 μ.

Host plants in Ohio Herbarium: Vitis quinquefolia, Cuyahoga Co., E. Claassen; Parthenocissus quinquefolia, Columbus, W. A. Kellerman; Vitis (cult), Columbus, W. A. Kellerman; Ampelopsis quinquefolia, Columbus, H. H. Richardson, C. M. Weed, W. A. Kellerman, Oberlin, Toledo, F. D. Kelsey.

Uncinula macrospora Peck. Mycelium thin; perithecia 95–165 μ; cells 10 μ; appendages 50–130 in number, $\frac{1}{3}$–1 times diameter of perithecium, nonseptate, colorless, thicker-walled toward base; asci 8–14, often curved, 54 x 29–65 x 35 μ; spores 2, 30 x 16 μ.

Host plants in Ohio Herbarium: Ulnus americana, Wyandotte Co., Thos. Bosner, Columbus, W. C. Werner, Fairfield Co., W. A. Kellerman; Ulmus fulva, Canal Winchester, W. C. Werner, Warren Co., W. A. Kellerman, Columbus, C. M. Weed.

Otherwise reported in Ohio: Ulmus americana, Fairfield Co., A. D. Selby, F. Detmers, Columbus, A. D. Selby; Ulmus fulva, Columbus, W. C. Werner.

Uncinula flexuosa Peck. Mycelium persistent on upper side of leaf; perithecia scattered, 85–156 μ in diameter; cells distinct, 17 μ: appendages 14–60, length equaling diameter of perithecium, colorless, nonseptate, becoming enlarged, flexuose and thickwalled at apex; asci 4–11, short-stalked, 50 x 30–58 x 38 μ; spores 8, 18–22 x 10 μ.

Host plants in Ohio Herbarium: Aesculus glabra, Columbus, C. M. Weed; Aesculus sp., Oberlin, F. D. Kelsey.

Otherwise reported in Ohio: Aesculus glabra, Columbus, F. M. Webster.

Uncinula clintoni Peck. Perithecia 80–130 μ in diameter; cells 10–20 μ; appendages 10–35, 1–2 times diameter of perithecium, colorless or light brown at base, thick-walled, swollen at apex; asci 3–10, short-stalked, 40 x 34–62 x 40 μ; spores 3–7, 20 x 10–25 x 13 μ.

Host-plants in Ohio Herbarium: Tilia americana, Cuyahoga Co., E. Claassen.

Otherwise reported in Ohio: Tilia americana, Oberlin, F. D. Kelsey.

Uncinula salicis (DC) Winter. Perithecia globose-depressed, 90–175 μ in diameter; cells 10–15 μ; appendages numerous, 100–150, crowded, $\frac{3}{4}$–$1\frac{1}{2}$ times diameter of perithecium, nonseptate or 1 septate at base, colorless, gradually enlarging toward apex; asci 8–14, stalked, 55 x 30–80 x 40 μ; spores 4–6, 20 x 10–26 x 15 μ.

Host plants in Ohio Herbarium: Salix sp., Bowling Green, Columbus, Fairfield Co., W. A. Kellerman, Toledo, F. D. Kelsey; Salix glaucophylla, Cedar Point, E. Claassen; Salix cordata, Cuyahoga Co., E. Claassen, Columbus, W. A. Kellerman; Salix humulis, Amanda, W. A. Kellerman; Salix nigra, Columbus, C. M. Weed; Salix petiolaris, Columbus, C. M. Weed; Scutellaria latirifolia, Williams Co., W. A. Kellerman; Populus monilifera, Cedar Point, E. Claassen; Populus tremuloides, Cedar Point, E. Claassen.

Otherwise reported in Ohio: Scutellaria laterifolia, Columbus, A. D. Selby.

Uncinula cicrinata C. & P. Perithecia scattered, somewhat lenticular, 160–225 μ diameter; cells obscure, 10–14 μ; appendages crowded, very numerous, length a little less than diameter of perithecium, nonseptate, colorless, apex not helicoid; asci 9–26, 68 x 29–86 x 40 μ; spores 8, 18 x 20–22 x 14 μ.

Host plants in Ohio Herbarium: Acer saccharum, Acer rubrum, Acer saccharinum, Cuyahoga Co., E. Claassen; Acer dasycarpum, Columbus, C. M. Weed.

Otherwise reported in Ohio: Acer rubrum, Fairfield Co., A. D. Selby; Acer saccharum, Columbus, C. M. Weed.

PODOSPHAERA Kunze.

Key to the Ohio Species.

1. Appendages clear, except at base; branches of apex not swollen .... *biuncinata*
   Appendages dark-brown for more than half their length; branches or apex swollen .... *oxyacanthae*

Podosphaera biuncinata, C. & P. Perithecia subglobose, 55–72 μ in diameter; appendages equatorial, 4–15 in number, 3–5 times diameter of perithecium, straight, nonseptate, colorless, or light brown at base, apex once dichotomously branched, branches variable and often recurved; ascus short-stalked, 45 x 40–50 x 48 μ; spores 8, 20 x 11–24 x 13 μ.

Host plants in Ohio Herbarium: Hamamelis virginiana, Summit Co., Cuyahoga Co., E. Claassen.

Podosphaera oxyacanthae (DC) DeB. Perithecia subglobose, 64–90 μ in diameter; cells 10–18 μ wide; appendages usually equatorial, sometimes nearer apex, 4–30 in number, ½–6 times diameter of perithecium, septate, brown for more than half their length, apex 2–4 times dichotomously branched, branches short, tips of ultimate branchlets swollen; ascus 58 x 45–90 x 75 μ; spores 18 x 10–30 x 17 μ.

Host plants in Ohio Herbarium: Cherry (cult) Ottawa Co., W. A. Kellerman; Prunus virginiana, Cedar Point, E. Claassen; Spiraea tomentosa, Fairfield Co., W. A. Kellerman; Prunus cerasus, Columbus, H. H. Richardson.

Otherwise reported in Ohio: Cherry (cult), Columbus, C. M. Weed, F. Detmers, Dayton, Jos. Potts.

Key to the Ohio Species.

1. Appendages angularly bent, branches lax and irregular .... *euphorbiae*
   Appendages not so 2
2. Ultimate branchlets usually recurved 3
   Ultimate branchlets not recurved 4
3. Appendages long and flaccid, apex much branched, ornate and close .... *alni*, var. *extensa*
   Appendages short, not flaccid, ultimate branchlets all distinctly recurved .... *alni*
   Appendages 2½–8 times diameter of perithecium, apex moderately branched, widely forked .... *alni*, var. *vaccinii*

4. Appendages 3-7 times diameter of perithecium, colored nearly to apex . . . . *russellii*
   Apendages colorless 5
5. Branches lax and irregular . . . . *diffusa*
   Branches close and regular, digitate . . . . *grossulariae*

Microsphaera euphorbiae (Peck) B. & C. Perithecia 85–145 μ; in diameter; cells 10–15 μ; appendages 7–28, 2½–8 times diameter of perithecium, contorted, colorless, nonseptate, 3–4 times dichotomously branched, branches lax and irregular; asci 4–13, short-stalked, 48 x 26–66 x 35 μ; spores 4, 19 x 10–21 x 12 μ.

Host plants in Ohio Herbarium: Euphorbia corollata, Toledo, F. D. Kelsey.

Otherwise reported in Ohio: Euphorbia corollata, Columbus, E. M. Wilcox.

Microsphaera alni (Wallr.) Salm. Mycelium thin; perithecia 66–110 μ in diameter; cells 10–15 μ; appendages 4–26, ⅓–2½ times diameter of perithecium, colorless, often darker at base, apex 3–6 times dichotomously branched, ultimate branchlets recurved; asci 3–8, 42 x 32–70 x 50 μ, short-stalked; spores 4–8, 18 x 10–23 x 12 μ.

Host plants in Ohio Herbarium: Sambucus canadensis, Cuyahoga Co., E. Claassen; Gleditschia triacanthus, Columbus, W. A. Kellerman, Alton, F. L. Stevens, Brown Co., W. A. Kellerman, Hebron, Kellerman and Beatty, Warren Co., Fairfield Co., W. A. Kellerman, Columbus, Weed and Craig; Castanea dentata, Cuyahoga Co., E. Claassen; Cornus candidissima, Cuyahoga Co., E. Claassen; Syringa vulgaris, Cuyahoga Co., E. Claassen, Columbus, E. E. Bogue; Lilac (cult), Hamilton Co., W. H. Aiken, Sugar Grove, W. A. Kellerman; Vibernum acerifolium, Platanus occidentalis, Lonicera ciliata, Cuyahoga Co., E. Claassen, Viburnum cassinoides, Ottawa Co., W. A. Kellerman; Castanea sativa, var. americana, Sugar Grove, Wilcox, Bogue and Weed; Lathyrus myrtifolius, Painesville, W. C. Werner.

Otherwise reported in Ohio: Euonymus atropurpureus, Ross Co., W. A. Kellerman, Columbus, A. D. Selby; Sambucus canadensis, Columbus, A. D. Selby; Platanus occidentalis, Columbus, A. D. Selby; Castanea sativa var. americana, Ross Co., W. A. Kellerman; Gleditschia triacanthos, Ross Co., W. A. Kellerman.

Microsphaera alni extensa (C. & P.) Salm. Mycelium persistent; perithecia gregarious, 90–140 μ in diameter; cells 10–20 μ; appendages 8–19, 2½–6 times diameter of perithecium, flexuous, colorless, nonseptate, walls thickened toward base, apex 3–5 times dichotomously branched, branching close, ultimate branchlets distinctly recurved; asci 3–8, short-stalked, 58 x 34–72 x 45 μ; spores usually 6, 22 x 12–26 x 15 μ.

Host plants in Ohio Herbarium: Quercus sp., Columbus, C. M. Weed; Quercus tinctoria, Lawrence Co., W. A. Kellerman; Quercus macrocarpa, Columbus, C. M. Weed; Quercus rubra, Columbus, E. V. Wilcox; Quercus nigra, Fairfield Co., W. A. Kellerman; Quercus coccinea, Worthington, C. M. Weed.

Microsphaera alni vaccinii (Schw.) Salm. Perithecia scattered, 70–145 μ in diameter; cells 10–20 μ; appendages 4–22, 2½–8 times diameter of perithecium, colorless, or darker at base, nonseptate, apex 2–4 times dichotomously branched, ultimate branchlets recurved; asci 2–16, 45 x 28–72 x 38 μ; spores 4–6, 18 x 10–22 x 13 μ.

Host plants in Ohio Herbarium: Vaccinium vacillans, Portage Co., Lake Co., E. Claassen, Vaccinium corymbosum, Portage Co., E. Claassen; Catalpa bignonoides, Columbus, C. M. Weed, Oberlin, F. D. Kelsey, Toledo, F. D. Kelsey.

Microsphaera russellii Clinton. Perithecia scattered, 70–118 μ in diameter; cells 6–14 μ; appendages 5–14, 3–7 times diameter of perithecium, septate, colored nearly to apex, 2–4 times dichotomously branched, branches irregular and lax, tips not recurved, primary branches long; asci 4–9, short-stalked, 42 x 24–56 x 32 μ; spores 4, 18 x 10–22 x 12 μ. Appendages not branched until fully mature.

Host plants in Ohio Herbarium: Oxalis stricta, Hamilton Co., W. H. Aiken, Columbus, W. A. Kellerman.

Otherwise reported in Ohio: Oxalis recurva, E. M. Wilcox.

Microsphaera diffusa C. & P. Perithecia 55–126 μ in diameter; cells 10–20 μ; appendages 4–30, 1–1 2-7 times diameter of perithecium, sometimes septate in lower half, colorless, thicker walled toward base, apex 3–5 times irregularly dichotomously branched, tips swollen and not recurved; asci 4–9, 48 x 28–60 x 30 μ, with very short stalk; spores 4, 18 x 9–22 x 11 μ.

Host plants in Ohio Herbarium: Meibomia canescens, Meibomia dillenii, Cuyahoga Co., E. Claassen; Desmodium sp., Franklin Co., F. L. Stevens; Desmodium nudiflorum, Columbus, C. M. Weed.

Otherwise reported in Ohio: Desmodium canescens, Columbus, C. M. Weed, F. Detmers, A. D. Selby.

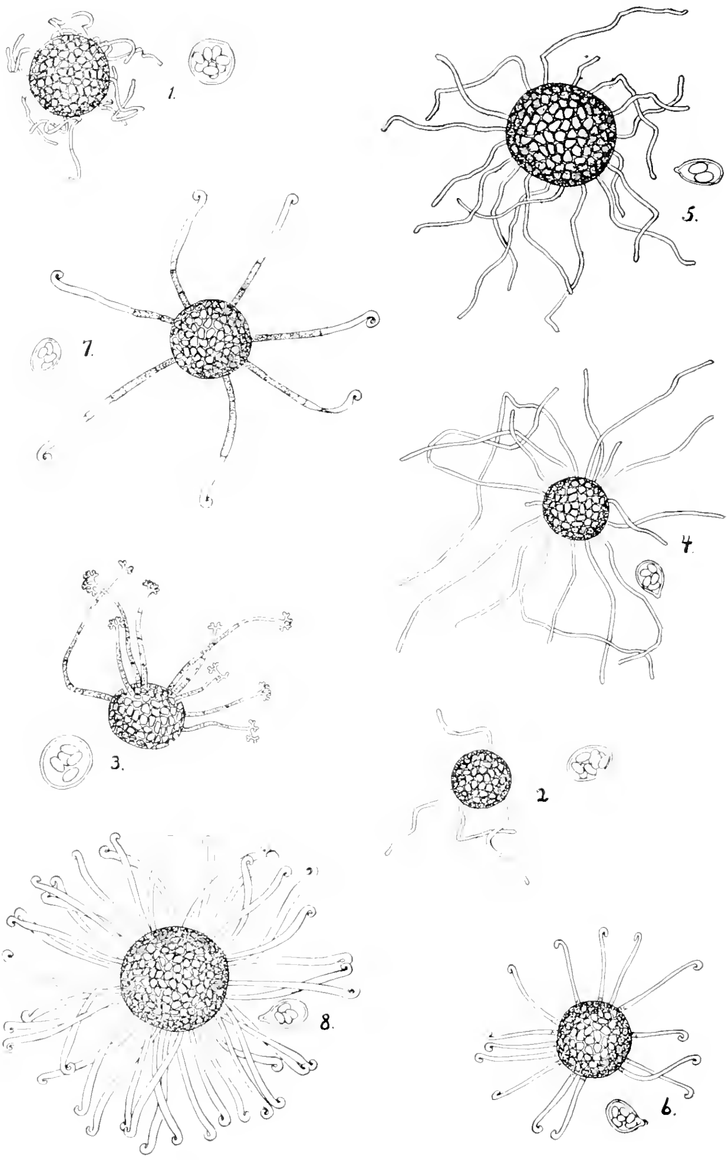
Microsphaera grossulariae (Wallr.) Lev. Peritheeia 65–130 μ in diameter; cells 14–20 μ; appendages 5–22, 1–1¾ times diameter of perithecium, colorless, nonseptate, thicker walled toward base, apex 4–5 times dichotomously branched, branches close and regular, and ultimate branches long, giving a digitate appearance; asci 4–10, short stalked, 40 x 28–62 x 38 μ; spores 4–6, 20 x 12–28 x 16 μ.

Host plants in Ohio Herbarium: Sambucus canadensis, Columbus, W. A. Kellerman, Sugar Grove, W. A. Kellerman.

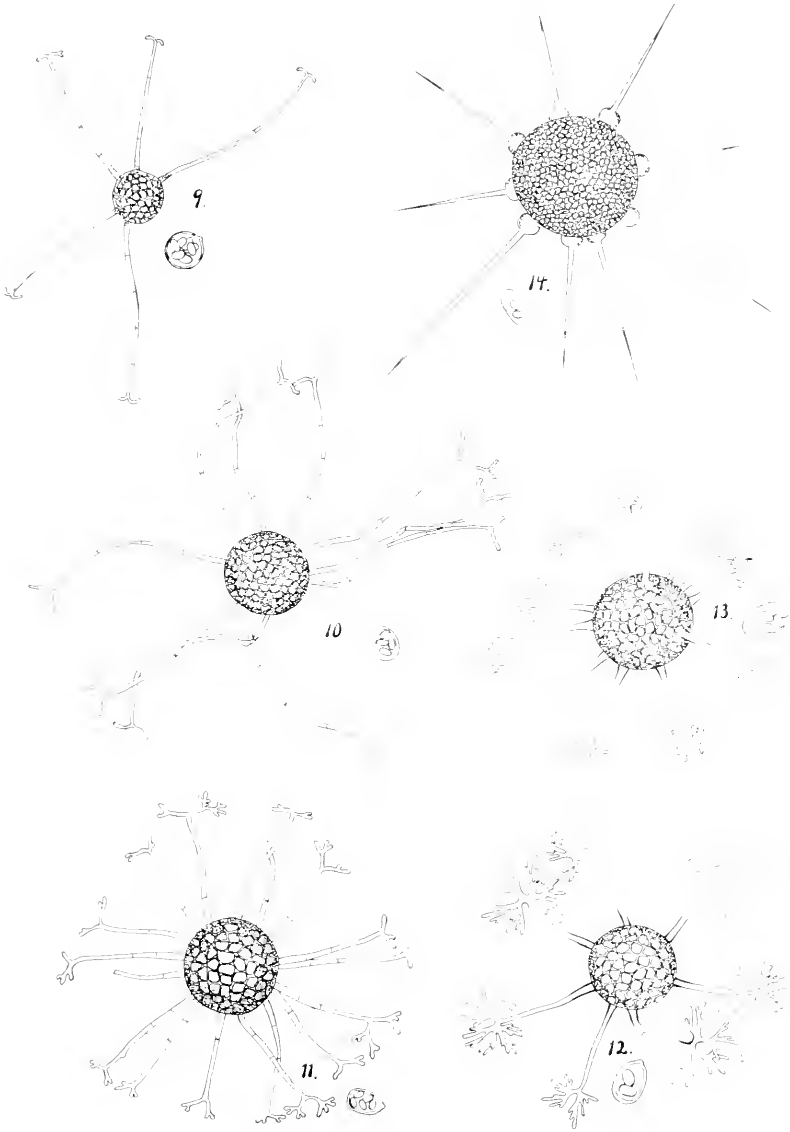
Phyllactinia Lev.

Phyllactinia corylea (Pers.) Karst. Perithecia 150–275 μ in diameter; cells 10 to 15 μ; appendages 8–12, equatorial, length ¾ to 4 times diameter of peritheeium, sharp-pointed, with bulbous base; asci 5–20, stalked, 30 x 90 μ; spores 2, 14 x 18 μ.

OHIO NATURALIST. *Plate IX.*



O'KANE on "Powdery Mildews."



O'KANE on "Powdery Mildews."

Host plants in Ohio Herbarium: Carpinus caroliniana, Fairfield Co., W. A. Kellerman; Catalpa (cult), Warren Co., Catalpa bignonoides, Fairfield Co., W. A. Kellerman; Alnus rugosa, Licking Co., J. G. Sanders; Magnolia acuminata, Franklin Co., J. H. Schaffner; Quercus rubra, Toledo, F. D. Kelsey; Fagus americana, Worthington, C. M. Weed; Castanea sativa, var. americana, Knox Co., H. J. Detmers; Quercus sp., Fairfield Co., W. A. Kellerman.

Otherwise reported in Ohio: Phlox paniculata, Columbus, A. D. Selby.

Explanation of Plates IX and X.

Figures 1 to 13, inclusive, were drawn at a magnification of 315 diameters, and cuts made at two-thirds reduction. These figures, therefore, are shown at a magnification of 105 diameters.

Figure 14 was drawn at a magnification of 210 diameters, and cut made at two-thirds reduction. This figure, therefore, is shown at a magnification of 70 diameters.

Fig. 1. Sphaerotheca humuli (DC.) Burr.
Fig. 2. Sphaerotheca phytoptophila Kell & Swingle.
Fig. 3. Podosphaera oxyacanthae DeB.
Fig. 4. Erysiphe polygoni DC.
Fig. 5. Erysiphe cichoracearum DC.
Fig. 6. Uncinula clintoni Pk.
Fig. 7. Uncinula necator (Schw.) Burr.
Fig. 8. Uncinula salicis (DC.) Winter.
Fig. 9. Podosphaera biuncinata C. & P.
Fig. 10. Microsphaera russellii Clint.
Fig. 11. Microsphaera diffusa C. & P.
Fig. 12. Microsphaera grossulariae (Wallr.) Lev.
Fig. 13. Microsphaera alni (Wallr.) Salmon.
Fig. 14. Phyllactinia corylea (Pers.) Karst.

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TABLE OF CONTENTS.

NOTES ON NEW OHIO AGARICS.

WILMER G. STOVER.

The following Agarics have not been previously reported from Ohio. All were collected near Oxford, Ohio, by the writer, unless otherwise noted. Most of them were determined or confirmed at the New York Botanical Garden or at Albany and were, so far as possible, compared with specimens at those places, in some cases with type specimens.

My thanks are due to Dr. W. A. Murrill and C. H. Peck for the privilege of examining specimens and other favors.

The following notes are intended to present only the essential characters of the species named. For fuller descriptions the reader is referred to mushroom books.

Lactaria rimosella, Peck. Pileus reddish-brown, dry, glabrous, becoming rimose-areolate; latex somewhat watery; lamellae close, decurrent; stipe colored like the pileus. June. Plants identified by Miss G. S. Burlingham. North American Flora, Vol. 9, Part 3, Page 198.

Russula luteobasis, Peck. Pileus red, becoming wholly yellowish or in the center only; lamellae equal, white or creamy yellow, adnexed; stipe stuffed, white above, yellow or orange-yellow at the base. August. Bull. Torr. Bot. Club, 31: 179, Apr. 1904.

Russula crustosa, Peck. This plant is closely related to *R. virescens* (Schaeff) Fr. and is doubtless often reported under that name. The chief characters distinguishing it from R. virescens are the subviscid pileus, the striate margin, smooth disk and the small areolate scales of the pileus. It is more variable in

color than R. virescens, ranging from green or greenish to ochraceous. Dr. Kauffman* suggests that Hard's figure (150) is of this species rather than R. virescens as labeled and I am inclined to agree. July to September.

Russula subsordida, Peck. The whole plant becomes smoky-brown when old and the flesh changes to that color when cut or broken. Pileus glabrous, viscid when young, at first whitish, lamellae close, adnate. It is separated from R. sordida, Peck, by its viscid pileus; from R. nigricans, (Bull.) Fr., by the close lamellae, and from R. densifolia, Secr , by the flesh not becoming reddish when wounded. September.

Russula flavida, Frost. Pileus and stipe yellow, lamellae white; pileus dry and mealy; lamellae close, adnate; stem solid. I take this to be the plant described by Morgan as R. lutea, Fr. The latter has a viscid pileus, a white stipe and the lamellae are yellow or ochraceous. August and September.

Russula mariae, Peck. Pileus dry, dark crimson or purplish, minutely pulverulent or glaucous; lamellae close, adnate, whitish to yellowish; stipe solid, a little paler than pileus or nearly white. July. Determination confirmed byMiss Burlingham.

Russula earlei, Peck. Pileus glutinous, straw-colored or paler, margin even; lamellae thick, distant, adnate; stipe white. Rather easily distinguished by the pale, glutinous pileus and the distant gills August.

Clitocybe eccentrica, Peck. Pileus umbilicate or somewhat infundibuliform, hygrophanous, white or whitish, margin lobed, split or irregular; lamellae white or yellowish, close, narrow, decurrent; stipe often eccentric, becoming hollow. Growing on much decayed log. August. Identified by C. H. Peck.

Crepidotus cinnabarinus, Peck. Pileus sessile, minutely tomentose or pulverulent, cinnabar-red; lamellae rather broad, reddish-flocculent on the edge; spores ferruginous. Readily recognized from the color. On old stump in woods. Coll. A. T. Cox. July. Bull. Torr. Bot. Cl. 22: 489.

Galera crispa, Longyear. Pileus conic-campanulate, margin becoming crenulated and upturned; lamellae slightly adnexed, close, rather narrow, much crisped; stipe fragile, somewhat bulbous. In grass on University campus. June to August. Bot. Gaz. 28: 272.

Agaricus abruptibulbus, Peck. The pileus is usually white or yellowish but our specimens were tawny-yellow even when fresh. The stipe has a flattened bulb by which the plant may be distinguished from its nearest allies. The double annulus is another distinctive character. August. Coll. Master Hugh Fink. Identified by C. H. Peck. This plant was first named Agaricus abruptus, Peck.

* C. H. Kauffman, Michigan Species of Russula, Eleventh Report of Michigan Academy of Science, pp. 57 91.

Miami University, Oxford, Ohio.

NEW VARIETIES OF COMMON FERNS.

L. S. Hopkins.

For several years while collecting in the woods of Wayne County, Ohio, I have noted here and there occasional plants of Adiantum pedatum L. whose fronds differ very materially from those of the normal type. The difference consists mainly in the normal pinnules being replaced by linear branching pinnules which are partly fertile and partly sterile at their tips. This transposition may occur either at the end or the middle of the pinna, more often the latter.

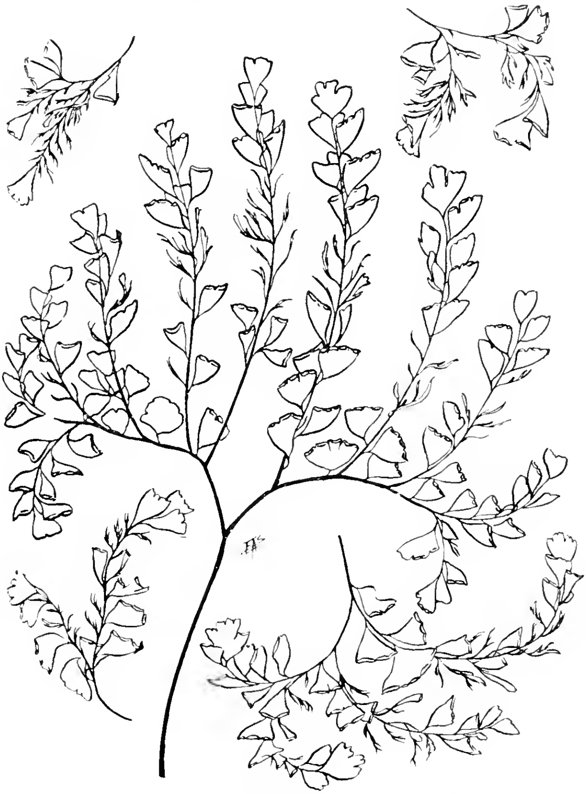

Fig. 1. Adiantum pedatum laciniatum Hopkins.

One of these plants was transplanted to the yard of the McFadden homestead in Wooster where it has been under observation for a period of four years. It seems to thrive in its new home and each year has continued to produce fronds of the type described.

The form is probably a sport but as such it seems to deserve a name as it is likely to occur elsewhere. Therefore, I propose the name:

Adiantum pedatum L. var. *laciniatum* Hopkins var. nov.

Pinnules linear, lanceolate, or oblanceolate, more or less branched; growing with the type; rocky wooded hillsides, Wayne County, O. (Fig. 1).

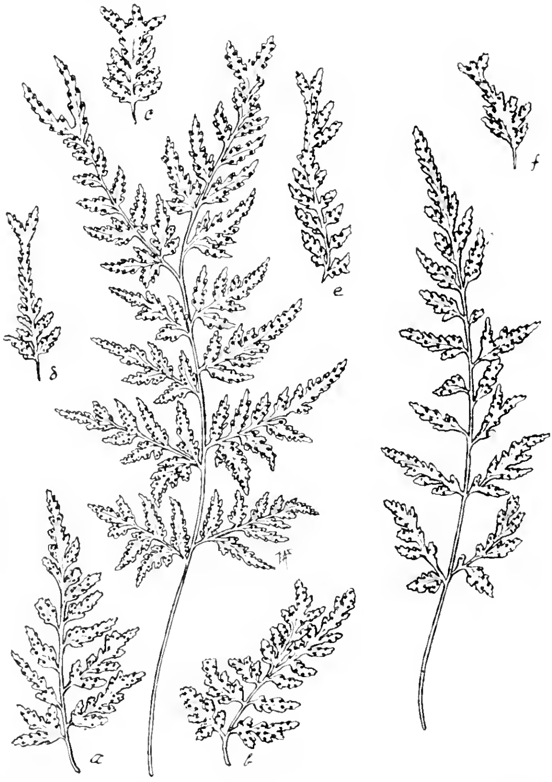

Fig. 2. Cystopteris fragilis cristata Hopkins. a, b, c. Apexes of frond. d, e, f, Pinnae.

In the latter part of August, 1909, in company with Mr. R. J. Webb, of Garrettsville, and Mr. A. N. Rood, of Phalanx, I visited Woodworth's Glenn, in Portage County.

A clear rapid flowing stream very suggestive of trout has cut out a small ravine through the sub-carboniferous (?) sandstone. In some places this ravine is quite narrow and the walls almost perpendicular.

The ordinary Fragile Bladder Fern grows in abundance upon these rocks. A hasty glance revealed the fact that it differed very materially from the ordinary form. The apexes of the frond and the tips of the pinnae are branched two to four times, acuminate, obtuse or emarginate.

The plant grows plentifully in the partially shaded ravine and the differences from the normal type of frond seem to warrant the name:

Cystopteris fragilis (L.) Bernh. var. *cristata* Hopkins, var. nov.

Apex of frond branched, the branches often dividing again; obtuse or acuminate, pinnae linear, lanceolate, broadly triangular, acuminate, acute or obtuse often branching into two or more irregular segments; in part on sandstone rocks, Woodworth's Glenn, Portage County, Ohio. (Fig. 2).

Pittsburgh High School.

WINTER-BUDS OF SPIRODELA POLYRHIZA (L.).

V. Sterki.

Last summer and fall, I brought home several kinds of "duckweeds," and kept them in aquaria, some of the latter being small tumblers. During September and October it was noticed that there were numerous small disks, or links, partly free, partly connected with *Spirodela* plants. They were flat, short-elliptical or oblong, or nearly circular, of about one to two mm. diameter, of a deep green color (darker than the spirodela disks), always rootless, without any visible venation and with a small, sharply defined, crescent-shaped, whitish to brownish hilum at the margin. Microscopic examination, made in February, showed them to have stomata on the upper surface and a slight but distinct purplish hue on the lower, inside of the epidermis.

With the approach of winter, the Spirodela plants faded and died, but these small bodies kept fresh and green, and most of them sank to the bottom. Some, however, were kept floating by the dead disks, now little more than skeletons. Some were seen as late as February, each being held between the two epidermal layers of its parent disk, near the hilum, partly emerging from the margin. Several score were in a small tumbler aquarium, near a window but not reached by direct sunlight until the end of winter. During the latter part of January, and up to the present it was noticed that each had a small gas bubble on its upper surface, probably oxygen, and some were raised to the surface by the same and kept floating. Many of them are now sprouting, at the hilum, while others are still at the bottom, unchanged. Another such small aquarium, with Lemna tri-

sulca, etc., was kept close to the window, where the sun had access for an hour or two on clear mornings. In that, the plants developed earlier, and at the present writing, several of them are fully developed, unmistakable *Spirodela polyrhiza*, with two disks several times the size of the bud, bright green, with distinct nervation, several roots and with the inferior side around the hilum purplish. On one of them, the bud is now fading and withering.

Thus the cycle is complete. The small bodies described were seen developing on the Spirodela plants, in late summer and fall, then detached or held only mechanically, surviving the winter at the bottom, rising to the surface in spring (premature indoors), producing new plants, and then dying. The observations are complete so far as they go; but more details and further investigations will be in place. It has not been ascertained whether one Spirodela disk produces only one bud or several, how early in the season they are produced and eventually whether some of them grow out into new plants in the same season; also the microscopic structure especially of the hilum when dormant and at the time of sprouting will be of interest. The buds should also be taken up from the bottom of ponds and pools in early spring and their development observed.

When the little bodies were first noticed, last fall, it was supposed that they might be "winter-buds," having the function of buds or bulbs, and the result sustained the diagnosis. Since the plant is rarely found blossoming and fruiting these buds are evidently the means of propagation of the species. But the term "bud" is not adequate. They may be compared with the bulblets of some Pteridophyta. Their significance is possibly nearest to that of tubers, like those of the Dahlia and potato, but the fact that they are provided with chlorophyl and stomata again sets them apart. Their configuration is in accordance with the simple structure of the plant itself.

It may be mentioned that a *Lemna* (*trinervis* Austin?) brought in and kept with the *Spirodela* showed nothing of the kind described; but it may have been overlooked; most of them died earlier than the Spirodela. *Lemna trisulca* L. keeps well and grows luxuriantly over winter, indoors, and is a very satisfactory plant for small aquaria.

New Philadelphia, Ohio, March 12, 1910.

NAIADES OF GRAND RIVER, OHIO.

L. B. Gary.

Lampsilis ventricosa (Barnes, Unio), fairly common.
" multiradiata (Lea, Unio), one specimen, Painesville, O.
" Luteola (Lamarck, Unio), most common.
" ligamentina (Lamarck, Unio), rather scarce at Mechanicsville, O.
" recta (Lamarck, Unio), not rare.
" iris (Lea, Unio), rather scarce.
" parva (Barnes, Unio), rather scarce.
Obovaria circulus (Lea, Unio), scarce.
Pytchobranchus phaseolus (Hildreth, Unio), rare.
Quadrula undulata (Barnes, Unio), abundant.
" Kirtlandiana (Lea, Unio), very rare.
" rubiginosa (Lea, Unio), not rare.
Unio gibbosus Barnes, rather common.
Symphynota compressa (Lea, Unio pressus), not plentiful.
" costata (Rafinesque, Alasmidonta), common.
Alasmidonta marginata Say, not very common.
Hemilastena ambigua, (Say, Alasmodonta), not rare.
Strophitus edentulus (Lea, Anodonta), common.
Anodontoides ferussacianus subcylindraceus? Lea, one specimen.
Anodonta grandis (decora?) Lea, common.

This list is the result of several years collecting at Mechanicsville, Austinburg Tp., Ashtabula Co., O., with the one exception noted.

263 Hoyt St., Buffalo, N. Y.

NAIADES OF CEDAR POINT, OHIO.

L. B. Gary.

Lampsilis ventricosa (Barnes, Unio), common.
" luteola (Lamarck, Unio), common.
" recta (Lamarck, Unio), scarce.
" nasuta (Say, Unio), rather scarce.
" alata (Say, Unio), common.
" gracilis (Barnes, Unio), plentiful.
Plagiola donaciformis (Lea, Unio), rare.
Obovaria circulus (Lea, Unio), very common.
Quadrula plicata (Say, Unio).
" undulata (Barnes, Unio).
" pustulosa ? (Lea, Unio), an imperfect specimen.
" rubiginosa (Lea, Unio), fairly common.
Unio gibbosus Barnes, fairly common.

Strophitus edentulus (Lea, Anodonta)? No specimen in my collection, but listed in my notes.

Anodontoides ferussacianus subcylindraceus Lea.?, one specimen.

Anodonta grandis Say, one specimen.

What appeared to be a white specimen of Quadrula coccineus Conrad, was found near the Lake Laboratory, and probably came from the Sandusky Bay. The balance of these shells were picked up on the shore of Lake Erie between Cedar Point and the Laboratory. The list is by no means complete, probably but simply shows what can be gathered in one season. Several species were taken alive.

XEROPHYTIC ADAPTATIONS OF APOCYNUM HYPERICIFOLIUM.

John H. Schaffner.

In the January, 1905, Ohio Naturalist, the writer presented some observations on the occurrence and development of mat plants, showing that some plants which are erect in an ordinary environment become prostrate, with radiating branches, when growing in exposed situations as on a sandbar or newly plowed prairie. While studying the xerophytic vegetation of Cedar Point, at Sandusky, Ohio, my attention was called to the pros-

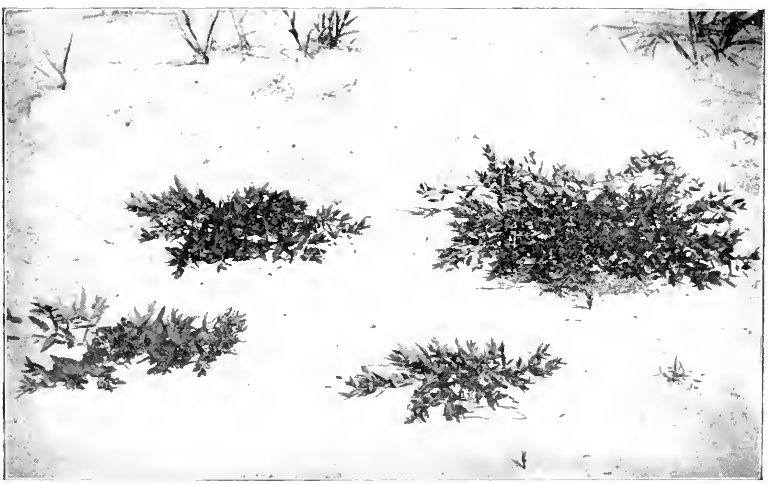

Fig. 1. Apocynum hypericifolium growing on a sand blow-out on Cedar Point.

trate condition of *Apocynum hypericifolium* Ait., the Clasping-leaf Dogbane, growing in the blowouts and on the sand-dunes. This is a rather rare plant in Ohio, being at present known only from this locality. The plants growing in less exposed conditions were nearly or quite erect.

The prostrate condition is brought about by a curve of the single main stem an inch or two above the ground. The lateral branches spread out in a more or less radiating fashion, producing a very close superficial imitation of a typical mat plant (Fig. 1). The bending over of the steam and branches brings most of the leaves into a more or less vertical position. The peculiarity seems to be an adaptation to the light, but other factors may also have an influence. The cause of the habit could probably be easily determined by experiment. The stems develop abundant anthocyan and the leaves are very glabrous and glaucous. This Dogbane is, therefore, a very perfect xerophyte being able to endure more easily perhaps than any other plant of the locality the intense light and heat often present in summer on the bare sand of the blow-out.

A PROPOSED LIST OF PLANTS TO BE EXCLUDED FROM THE OHIO CATALOG.

John H. Schaffner.

In the December, 1908, Ohio Naturalist, the writer published a paper entitled "Plants in the Ohio State List not Represented in the State Herbarium." In response to the request for information in regard to these plants a number of botanists have contributed data and specimens which establish a number of species as undoubted members of our flora. In the meantime, considerable work has been done on the plants of the state and the entire state herbarium has been studied more or less critically some of the more difficult groups by specialists. Many species represented by herbarium specimens cannot stand because of wrong identification. The present list is published with the hope that some may still be verified before publication of a new catalog of Ohio plants. Some records are based on fragmentary or imperfect specimens. In the future, all additions should be based on specimens about whose identification there can be no reasonable doubt. It is proposed, therefore, to exclude all of the species named below unless definite evidence of their existence in Ohio as indicated by herbarium specimens is forthcoming.

Probably some species should have been retained without question but it is evident that the only way to obtain a reliable

catalog is to use rather drastic measures. It will be easier to restore names to the list than to continue names whose standing is problematical and serve no purpose except to confuse the plant-geographers and ecologist. So far as the exclusion of foreign weeds and cultivated plants is concerned, if the list is not to represent known herbarium specimens a much larger number of probable species might be added. But it is believed that zeal for accuracy is more commendable than enthusiasm for new records and large numbers. The writer will greatly appreciate information which will tend to establish any species in the following list as a native or introduced Ohio plant:

Acer pennsylvanicum L. No specimens.
Achroanthes monophylla (L.) Greene. No specimens.
Aconitum uncinatum L. No specimens.
Adopogon carolinianum (Nutt.) Britt. No specimens
Agrimonia pumila Muhl. The specimen so labeled is A. mollis (T. & G.) Britt.
Agrostis asperifolia Trin. No specimens.
Allionia nyctaginea ovata (Pursh) Morong. The specimen labeled thus is the species.
Allium stellatum Ker. No specimens.
Alopercurus pratensis L. No specimens.
Alsine boreale (Bigel.) Britt. Beyond our range.
Alsine longipes (Goldie) Cov. Beyond our range. A specimen so labeled is too immature for determination.
Amaranthus crispus (Lesp. & Thev.) Br. No specimens.
Amaranthus lividus L. Beyond our range.
Amphiachris dracunculoides (DC.) Nutt. No specimens.
Artemisia abrotanum L. No specimens.
Artemisia absinthium L. No specimens.
Artemisia canadensis Mx. No specimens.
Asrum reflexum ambiguum Bickn. No specimens.
Asplenium fontanum (L.) Bernh. No specimens. Ohio record probably a mistake of labeling.
Aster acuminatus Mx. No specimens.
Aster claytoni crispens Burg. No specimens.
Aster cordifolius polycephalus Port. No specimens.
Aster divaricatus persaliens Burg. No specimens.
Aster dumosus L. No specimens.
Aster novi-belgii L. No specimens.
Aster novi-belgii laevigatus (Lam.) Gr. No specimens.
Aster ptarmicoides (Nees) T. & G. No specimens.
Aster salicifolius stenophyllus (Lindl.) Burg. No specimens.
Avena fatua L. No specimens.
Betula populifolia Marsh. No specimens.
Bicuculla eximia (Ker.) Millsp. No specimens.

Bidens leavis (L.) B. S. P. Beyond our range.
Blephariglottis grandiflora (Bigel.) Rydb. No specimens.
Bromus arvensis L. The specimen so labeled is B. racemosus.
Bromus asper Murr. No specimens.
Bromus breviaristatus (Hook.) Buckl. No specimens.
Broussonetia papyrifera (L.) Vent. No specimens.
Carex bullata Schk. No specimens.
Carex careyana Torr. No specimens.
Carex caroliniana Schw. No specimens.
Carex chordorhiza L. f. No specimens.
Carex deflexa Hornem. No specimens.
Carex formosa Dew. No specimens.
Carex goodenovii J. Gay. No specimens.
Carex interior capillacea Bail. No specimens.
Caerx novae-angliae Schw. No specimens.
Carex setacea Dew. No specimens.
Carex styloflexa Buckl. No specimens.
Carex tenella Schk. No specimens.
Carex tenera Dew. No specimens.
Carex tenuiflora Wahl. No specimens.
Carex umbellata Schk. No specimens.
Carex xanthocarpa Bickn. No specimens.
Castanea pumila (L.) Mill. No specimens.
Centaurea nigra L. No specimens.
Cerastium viscosum L. No specimens.
Chenopodium urbicum L. No specimens.
Chrysopsis grammifolia (Mx.) Nutt. No specimens.
Cinna latifolia (Trev.) Griseb. No specimens.
Claytonia caroliniana Mx. No specimens.
Claytonia perfoliata Donn. No specimens.
Clintonia borealis (Ait.) Raf. No specimens.
Cincus benedictus L. No specimens.
Convolvulus repens L. No specimens.
Corallorhiza corallorhiza (L.) Karst. No specimens.
Cornus baileyi Coult. & Evans. The specimen in the herbarium is from a cultivated plant.
Corylus rostrata Ait. No specimens.
Crepis tectorum L. No specimens.
Cyperus dentatus Torr. No specimens.
Cyperus ovularis (Mx.) Torr. No specimens.
Delphinium consolida L. All the specimens so named are D. ajacis L.
Delphinium carolinianum Walt. Beyond our range.
Deschampsia caespitosa (L.) Beauv. No specimens.
Eleocharis interstincta (Vahl.) R. & S. No specimens.
Eleocharis rostellata Torr. No specimens.
Equisetum scirpoides Mx. No specimens.

Eriophorum vaginatum L. No specimens.
Eriophorum gracile Koch. No specimens.
Eriophorum virginicum album Gr. No specimens.
Eupatorium serotinum Mx. No specimens.
Fragaria vesca L. No specimens.
Galium vernum L. No specimens.
Gentiana detonsa Rottb. No specimens.
Geranium dissectum L. No specimens.
Gerardia besseyana Britt. No specimens.
Geum macrophyllum Willd. Beyond our range.
Gifolia germanica (L.) Dum. No specimens.
Gratiola aurea Muhl. No specimens.
Gutierrezia texana (DC.) T. & G. No specimens.
Hedeoma hispida Pursh. Beyond our range.
Helianthus atrorubens L. No specimens.
Helianthus ambiguus (T. & G.) Britt. No specimens.
Heliotropium indicum L. No specimens.
Heliotropium anchusifolium Poir. No specimens.
Heteranthera reniformis R. & P. No specimens.
Hieracium greenii Port. & Britt. No specimens.
Houstonia tenuifolia Nutt. No specimens.
Hyoscyamus niger. L. No specimens.
Hypericum adpressum Bart. The specimen so named is probably H. perforatum L.
Juncus filiformis L. No specimens.
Juncus stygius L. No specimens.
Juncus brachycarpus Engl. No specimens.
Kneiffia linearis (Mx.) Spach. Beyond our range.
Kuhnistera candida (Willd.) Ktz. No specimens.
Lacinaria pycnostachya (Mx.) Ktz. No specimens.
Lactuca pulchella (Pursh) DC. No specimens.
Leontodon hastilis L. The plant so labeled is L. nudicaule (L.) Port.
Ligusticum scoticum L. No specimens.
Ligusticum canadense (L.) Britt. No specimens.
Limnanthemum lacunosum (Vent.) Griseb. No specimens.
Lithospermum linearifolium Goldie. No specimens.
Lobelia nuttallii R. & S. Beyond our range.
Lycopodium annotinum L. No specimens.
Lycopus europaeus L. No specimens.
Mariana mariana (L.) Hill. No specimens.
Meibomia arenicola Vail. The plant so labeled is probably M. marylandica (L.) Ktz. or M. obtusa (Muhl.) Vail.
Mentha aquatica L. No specimens.
Mentha sativa L. No specimens.
Mitella nuda L. No specimens.
Monarda citriodora Cerv. No specimens.

Myosotis palustris (L.) Lam. No specimens.
Myrica cerifera L. No specimens.
Myriophyllum tenellum Bigel. No specimens.
Nabalus serpentarius (Pursh) Hook. No specimens.
Nymphaea kalmiana (Mx.) Sims. No specimens.
Ophioglossum engelmanni Prantl. Wrong identification.
Onosmodium virginianum (L.) DC. No specimens.
Orchis rotundifolia Pursh. No specimens.
Oryzopsis juncea (Mx.) B. S. P. No specimens.
Oryzopsis asperifolia Mx. No specimens.
Oxycoccus oxycoccus (L.) MacM. No specimens.
Panicularia obtusa (Muhl.) Ktz. No specimens.
Panicum lanuginosum Ell. No specimens.
Panicum pseudopubescens Nash. No specimens.
Panicum xanthophysum Gr. No specimens.
Papaver dubium L. No specimens.
Parthenocissus quinquefolia laciniata Planch. No specimens.
Paspalum setaceum Mx. No specimens.
Peramium repens (L.) Salisb. No specimens.
Phaseolus polystachyus (L.) B. S. P. No specimens.
Philadelphus grandiflorus Willd. Beyond our range.
Philadelphus inodorus L. No specimens.
Plantago elongata Pursh. No specimens.
Poa debilis Torr. No specimens.
Polygala incarnata L. No specimens.
Polygonum careyi Olney. No specimens.
Polygonum cilinode Mx. No specimens.
Polygonum ramosissimum Mx. This is a salt marsh plant. The specimen so named is P. camporum Meisn.
Potamogeton spirillus Tuck. No specimens.
Potamogeton vaseyi Robb. No specimens.
Potenlilla canadensis simplex (Mx.) T. & G. No specimens.
Potenlilla sulphurea Lam. The specimens are P. recta L.
Ptilimnium capillaceum (Mx.) Raf. No specimens.
Pyrola asarifolia Mx. Beyond our range
Pyrola uliginosa Torr. Beyond our range.
Quamoclit quamoclit (L.) Britt. No specimens.
Quercus nana (Marsh.) Sarg. No specimens.
Ranunculus arvensis L. Probably not in Ohio.
Ranunculus ovalis Raf. Probably not in Ohio.
Ribes nigrum L. No specimens.
Robinia hispida L. Beyond our range.
Rosa canina L. No specimens.
Rosa cinnamomea L. No specimens.
Rosa nitida Willd. Beyond our range.
Rubus baileyanus Britt. No specimens.
Rubus canadensis L. No specimens.

Rubus frondosus Bigel. No specimens.
Rubus neglectus Peck. No specimens.
Rubus setosus Bigel. No specimens.
Rubus triviàlis Mx. Beyond our range.
Rumex patientia L. No specimens.
Rumex sanguineus L. No specimens.
Rynchospora fusca (L.) R. & S. The only specimen so labeled is a Juncus.
Sagittaria engelmanniana Sm. No specimens.
Salix alba coerulea (Sm.) Koch. No specimens.
Salvia verbenaca L. No specimens.
Scirpus sylvaticus L. No specimens.
Sedum reflexum L. Not properly identified.
Senecio lobatus Pers. No specimens.
Silphium integrifolium Mx. No specimens.
Smilax bona-nox L. No specimens.
Smilax pseudo-china L. No specimens.
Solidago odora Ait. No specimens.
Spiraea corymbosa Raf. Beyond our range.
Spiraea prunifolia Sieb. Specimen imperfect.
Trautvetteria carolinensis (Walt.) Vail. No specimens.
Triadenum petiolatum (Walt.) Britt. Beyond our range.
Trillium undulatum Willd. No specimens.
Vaccinium pallidum Ait. Beyond our range.
Valeriana uliginosa (T. & G.) Rydb. Specimen so labeled is V. officinalis L.
Verbesina occidentalis (L.) Walt. No specimens.
Vernonia glauca (L.) Britt. The two specimens so labeled have a purplish pappus and are the ordinary V. altissima Nutt.
Vincetoxicum gonocarpos Walt. No specimens.
Woodsia ilvensis (L.) R. Br. No specimens.
Woodwardia areolata (L.) Moore. No specimens.
Xanthium strumarium L. No specimens.
Xyris caroliniana Walt. No specimens.
Zizaniopsis miliacea (Mx.) D. & Asch. No specimens.

NOTE ON THE ORGANIZATION OF THE BIOLOGICAL CLUB OF THE OHIO STATE UNIVERSITY.

MALCOLM G. DICKEY.

On November 2, 1888, a number of persons interested in natural sciences met at the home of Mr. C. M. Weed to consider the organization of a biological club. A committee of three members, Messrs. Lazenby, Thorne and Weed was appointed to draw up a scheme of organization. Another meeting was held November 5th, when the formal organization of the club was

accomplished, with the following charter members present: Moses Craig, W. S. Devol, J. F. Hickman, D. S. Kellicott, W. R. Lazenby, W. G. Green, C. P. Sigerfoos, C. S. Thorne, and C. M. Weed. The orgainzation was called the Biological Club of the Ohio State University, and Agricultural Experiment Station. Meetings were held fortnightly at the homes of the members.

Later the Club met in Horticultural Hall and finally, from 1891 to 1900, in Botanical Hall. The first officers were: President, C. E. Thorne; Vice President, D. S. Kellicott, and Secretary, C. M. Weed.

At the meeting of November 3rd, 1891, a committee was appointed to consider the organization of a State Academy of Science. This resulted in the organization of our present State Academy on December 31, 1891.

The club has been active from the time of its organization with the exception of a period of seventeen months, from February 21, 1894, to September 19, 1895, during which no meetings were held. At the latter date the Club was again called together by Prof. Kellicott, and reorganized.

On March 5, 1900, a committee was appointed, consisting of Messrs. Herbert Osborn, W. A. Kellerman, and F. J. Tyler, to consider the advisability of establishing a biological bulletin to be published by the Club. The scheme was adopted, and the first editorial staff of the OHIO NATURALIST was elected on June 4, 1900.

The following is a list of the officers of the Club previous to 1900, when the printed records of the Club in the OHIO NATURALIST begin:

1888–1889—Pres., C. E. Thorne; Vice Pres., D. S. Kellicott; Sec., C. M. Weed.

1889–1890—Pres., D. S. Kellicott; Vice Pres., W. R. Lazenby; Sec., H. A. Surface.

1890–1891—Pres., W. R. Lazenby; Vice Pres., D. S. Kellicott; Sec., H. A. Surface.

1891–1892—Pres., W. A. Kellerman; Vice Pres., F. M. Webster; Sec., W. C. Werner

1892–1893—Pres., A. D. Selby; Vice Pres., J. H. McGregor; Sec., W. C. Werner.

1893–1894—Pres., W. C. Werner; Vice Pres., C. B. Morrey; Sec., J. H. McGregor.

1894–1895—No meetings held.

Sept. 19 to Nov. 1, 1895—Pres., W. A. Kellerman; Sec., E. M. Wilcox.

1895–1896—Pres., D. S. Kellicott; Vice Pres., Walter Fischer; Sec., E. M. Wilcox.

1896–1897—Pres., F. S. Landacre; Vice Pres., J. W. T. Duvel; Sec., R. C. Osborn.

1897–1898—Pres., J. A. Bownocker; Vice Pres., F. L. Stevens; Sec., E. B. Williamson.
1898–1899—Pres., W. R. Lazenby; Vice Pres., J. H. Schaffner; Sec., E. L. Fullmer.
1899–1900—Pres., J. H. Schaffner; Vice Pres., J. S. Hine; Sec., F. L. Landacre.

MEETINGS OF THE BIOLOGICAL CLUB.

Orton Hall, March 7, 1910.

The club was called to order by the President, and the minutes of the previous meeting were read and approved.

Mr. T. M. Thompson, George T. Caldwell, V. L. Nelson, and W. C. Lasseter were elected to membership.

Dr. E. F. McCampbell then gave an illustrated lecture on "Impressions of Mexico." Dr. McCampbell visited Mexico City last December in order to study typhus fever. He gave some account of the country and its people, and spoke more particularly of the study of typhus fever and observations of conditions in Mexican hospitals.

A large number of visitors were present.

Orton Hall, April 11 1910.

The Club was called to order by the President and the minutes of the previous meeting read, and approved.

Mr. O. E. Hatton and J. W. McBurney were elected to membership.

Prof. J. C. Hambleton spoke of his work on the genus Anasa. This is typically a Mexican, and Central American genus. There are six species found in the United States. Prof. Hambleton has found a specimen which he thinks belongs to a new species.

Prof. Lazenby then gave an account of his investigations of Catalpa growth. There are four species of Catalpa, two foreign, and two native, the Southern, and Western or Hardy Catalpa. The tree is not, strictly speaking, native to Ohio, but has become quite popular for planting for commercial purposes. It makes a rapid growth, and has a great variety of uses.

Mr. B. F. Wells told of a trip with Prof. Griggs in Hocking County during the spring vacation.

Prof. Schaffner spoke of the revision of the State Herbarium. Two hundred species were removed from the list.

Prof. Lazenby made some remarks on the effect of limestone upon the distribution of plants.

M. G. Dickey, Secretary.

Date of Publication, June 9, 1910.

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TABLE OF CONTENTS.

A CEDAR BOG IN CENTRAL OHIO.*

ALFRED DACHNOWSKI.

Ohio is one of the states of a central region in which the dominant vegetation is the deciduous forest. Our forests are a type of plant formation, with a distinct physiognomy and growth-form, both of which are an expression of certain definite conditions of life. Deciduous forests characterize all regions in which there is an abundant rainfall well distributed through the growing season, a relatively high percentage of atmospheric humidity, and a relatively high annual sum total of temperature exposure. Before settlement by immigrants from Europe, Ohio was almost completely covered by dense forests. Here and there, in ravines, in depressions between morainal hills, on the highlands of watersheds, were restricted areas of bog and marshland, sometimes many thousands of acres in extent, "filled in" ponds and lakes, another type of plant formations, of which the component species now tenanting such areas, and their relative proportion seemed more like an allusion to the distant north. Indeed they are relicts of a boreal vegetation which skirted the border of a great ice sheet covering almost all of Ohio. For reasons which will be stated in another paper these isolated areas of northern plant societies maintained themselves, and remained behind during the great migration of plants, while most of the plant societies adjusted to a northern climate, retreated northward with the glaciers as the winter conditions of the glacial period slowly changed to the present climate.

*By permission of the State Geologist. Contribution from the Botanical Laboratories of Ohio State University, No. 57.

During the past summer the writer was directed to obtain for the Ohio State Geological Survey an estimate of the extent and value of the bog and marshland in Ohio, to determine the depth of these vegetable accumulations, the general physical and chemical characters of the deposits, and to study them with a view to their commercial and agricultural utilization.

The uses of peat are many. There has recently been shown a renewed interest in the problem of peat utilization. In Europe this question receives the most careful and exhaustive study by trained specialists. Reports from Europe indicate the success of various new processes, and it is therefore a matter of the greatest importance to determine the extent of our own peat resources, the conservation of which should be second to none of the other economic sources of wealth. Peat can be employed as packing material, bedding, absorbent, fertilizer; as insulating material, for paper pulp and cardboard; in woven fabrics, artificial wood, paving and building blocks, for mattresses. There are certain chemical by-products derived from the distillation of peat as alcohol, ammonium sulphate, nitrates, and various dyes, the demand for which is steadily increasing. An interesting chapter in peat utilization is that of peat as fuel, power or producer gas, and coke. Many of our peat lands make our most productive agricultural soils when properly reclaimed. The most interesting studies are connected with the agricultural possibilities of peat soils; the nutritive value of peat to cereals and legumes, the character and variety of crops and garden plants which may be profitably cultivated on peat land; the sterility and the diseases of some of these soils; the nature of functional and structural responses in plants to such soils, and many other problems. This is a period of "intensive" agriculture, of investigation and discovery, and attention must sooner or later be turned towards our immense peat deposits.

The plants concerned in the formation and development of bogs and marshlands bear a relation of the utmost importance with reference to the purity, character, thermal, and physiological value of peat soils. The bearing of a floristic study upon the distribution of bog and marsh plants is also of considerable ecological and physiological interest. The aim has been, therefore, not only to present a list of the plants found in the various areas visited, but to show also the natural association of the plants into societies, and the order in which development and succession of plants in bogs proceeds. Moreover, the present bog and marsh plant societies are being destroyed so rapidly that some historical record is indeed of primary importance. In almost all places the work of man inaugurated conditions by cutting, clearing, fire, ditching, pasturing, and cultivation, which have destroyed much of the original flora of Ohio, and hence in many places a mixture

of arborescent plants, bog relicts, weeds, and invading plants has established itself. But even under such conditions an order of invasion and succession is to a certain extent characteristic in the movement of plants, and depends largely upon the extent to which the plants are especially enabled to cope functionally with the changing conditions and hold their ground. The time and chance factors, i. e., the opportunity for occupancy of the area, the relative amount of filling. and the degree of decomposition of peat which has occurred in the basin, are of equal importance in competition and maintenance. In all cases and at all times during the phases of the development of a plant formation the invasion, zonation, and succession of plant societies is intimately bound up with differences in available soil water content, and available food constituents which go concomitant with the degree of the decomposition of peat soils.

The most interesting of the many different kinds of bogs in Ohio is a Cedar bog near Urbana in Champaign County about forty miles west of Columbus. In a few places the character of the county is hilly, and in the depressions occur peat deposits. As a whole, however, the surface of the county is level and made up of plains. The general form is that of a broad shallow trough, lying north and south. Mad-River runs through the middle of it, and drains the main body of the territory.

On the east side of Mad River, in the southeastern part of Mad River Township, and extending largely over into Urbana Township (T5R11) in sections 31 and 32 is a tract of land known as the Dallas Cedar swamp. It is about six miles south of Urbana, and easily reached by means of the Ohio Electric Railway. The Cedar Swamp is a part of an area of cleared bog which comprises today about 600 acres. There was once an extensive deposit covering approximately 7,000 acres. On a small portion of land owned by M. and G. L. Dallas occur as described below groves of arbor vitae (Thuja occidentalis) in a good state of preservation. The groves occupy a habitat near which the soil water is derived from cold springs along the poorly drained river valley. A considerable number of soundings were made which disclosed for the first two feet a blackish brown compact, well decomposed, non-fibrous peat. At the third foot level the peat appeared dark brown, somewhat fibrous, with a considerable admixture of marl below. A number of well preserved logs and branches were encountered. At four feet the peat appeared brown and compact but fibrous in texture with fragments of rhizomes and roots. At the five feet level the sounding instrument encountered a coarse gravel with stones showing glacial striations. This rested on beds of quicksand and morainal till. The bog harbors a unique dependent flora which long throve here unmolested and was once a favorable resort for botanists. Now the cedars and the accompanying undergrowth

are rapidly disappearing as the clearing of the area nears completion. The indications are that in a few years the last vestige of this interesting aggregation of plants will be destroyed.

This type of bog is distinctly northern in its distribution and has not been observed by previous writers to occur south of the central part of Michigan. The brief time which could be given to the locality made a more detailed study and the mapping of the area impracticable. Yet the notes and records made have revealed a considerable number of species hitherto supposed to be confined to the states north of Ohio.

In several places the groves of arbor vitae are dense pure stands or facies with scarcely any undergrowth. The association has only a single vertical layer in which the lowermost branches of the component individuals bear a common spacial relation to light. The ground is littered with cedar foliage and only occasionally small sprouts of the chokeberry (Aronia arbutifolia), and stunted seedlings of yellow poplar (Liriodendron tulipifera) or small plants of the spice bush (Benzoin aestivale), alders, and woodbine are visible; generally there are no members of a subordinate species other than a few mosses and liverworts. In more open stands in which the effects of fire and cuttings are still present the arbor vitae is found here in association with the red maple (Acer rubrum), yellow poplar, (Liriodendron tulipifera), black ash (Fraxinus nigra), white walnut (Juglans cinerea), Sycamore (Platanus occidentalis), and wild cherry (Prunus serotina). The undergrowth is not only numerous in species but of exceptional height and in five layers. The poison sumach (Rhus Vernix) reaches frequently a height of twenty-five feet. Other members of this structural part of the formation, and determining more specifically the physiognomy of the layer, are the alders (Alnus incana, A. rugosa), the winter-berry (Ilex verticillata), the chokeberry (Aronia arbutifolia), and the round leafed dogwood (Cornus circinata). The inferior layers which seem to be entirely determined by the density of the mixture of facies are really overlapping communities of woodland and bog plants. There seems scarcely no relation to habitat factors. Seedlings and sprouts occur in all directions, in various degrees of abundance, and only the less hardy plants lose ground, thus producing examples of an indiscriminate alternation. The spice bush (Benzoin aestivale) is only of relatively less importance in the (second) stratum of bushes to the red bud (Cercis canadensis) and the elderberry (Sambucus canadensis).

The subordinate position with regard to the taller species is occupied by the cinnamon fern (Osmunda cinnamomea), the meadow rue (Thalictrum dasycarpum), the spikenard (Aralia racemosa), the bladder fern (Cystopteris bulbifera), and touch-me-not (Impatiens sp.). With them in varying abundance occur

as a lower herbaceous layer the maiden-hair fern (Adiantum pedatum), the dwarf raspberry (Rubus triflorus), wood ferns (Aspidium cristatum), miterwort (Mitella diphylla), wakerobin (Trillium erectum, T. grandiflorum), false solomon's seal (Smilacina trifolia), violet (Viola blanda), the star flower (Trientalis americana), the Indian cucumber-root (Medeola virginiana), manna grass (Glyceria Torreyana), and others.

In many places the various shrub layers immediately below the trees interpose as dense screens. These are often of sufficient density to reduce the light to a diffuseness which leads to frequent modification and a consequent rearrangement of the individual plants in the ground stratum. The number of such plants present is not large; they are all past flowering when shade conditions become extreme. The little mayflower (Maianthemum canadense) and various mosses and liverworts are the more resistant members of the living ground cover; they tend to disappear only when the shade condition approaches a light value similar to that of the pure stands of cedar.

To the east of the mature formation and adjoining it is an open area; in it occur a number of low wet places. The water of the cold springs is overcharged with carbonate of lime. The average soil moisture content is near saturation, and the soil temperature uniformly low throughout the year. In other places the water content is not quite so high, but higher usually than in any of the soils frequented by the cedars. Testborings indicate a surface layer of black non-fibrous peat about two feet deep, resting on a cream colored, fine grained marl, three feet in depth and underlain by sandy gravel. The marl is frequently of the nature of calcareous tufa. In the wetter habitat the plant association resembles that of an open sedge zone. The dominant plants are the rushes Juncus brachycephalus, Eleocharis obtusa, E. palustris, and Scirpus americanus. The physiognomy changes in places on account of an admixture of shield fern (Aspidium Thelypteris) and the parnassus (Parnassia caroliniana), with an occasional lizard's tail (Saururus cernuus), some goldenrods (Solidago Riddellii, S. ohioensis), the Canadian burnet (Sanguisorba canadensis), twayblade (Liparis Loeselii), water avens (Geum rivale), millet grass (Milium effusum), the marsh bellflower (Campanula aparinoides), lousewort (Pedicularis lanceolata), the golden ragweed (Senecio aureus) and swamp asters (Aster puniceus, var. lucidulum). Until recently orchids (Habenaria psycodes) and lady slippers (Cypripedium hirsutum, C. parviflorum) were not uncommon.

Nearer the cedar groves a low shrub society appears, among which the shrubby cinquefoil (Potentilla fruticosa), the bog birch (Betula pumila), several willows (Salix discolor, S. petiolaris), the buckthorn (Rhamnus alnifolia), and dogwoods (Cornus stoloni-

fera, C. alternifolia), are the more characteristic members. The ground cover is almost throughout one of mosses such as Hedwigia albicans, Anomodon rostratus, and a species of Chara. In this association lateral zonation is most clearly in evidence and arises in part from the characteristic growth form of the respective species, and in part from the physical features of the habitat. Of the latter the factor chiefly concerned is the water content of the soil. The essential connection between this is evident where springs are the source of shallow pools. Tension lines in the vegetation (ecotones) are not well marked, however. The zones are too often incomplete or obscure. There is in consequence more or less of a transition from the ground layer of mats of mosses and algae to the lower grass and herbaceous layer and to the tertiary layer of bushes and shrubs.

The habitat across the road and south of the areas just described, bears less resemblance to extremes in water content. The cedars are of less mature age and size, and deciduous invaders are still lacking. Next to the arbor vitae the predominant trees are the yellow poplar and the red maple. The flora seems more distinctly related to a transition stage. This may be due to a former partial clearing of the area. The young cedar trees average a height of ten to fifteen feet, and appear to occur in about equal abundance in every quadrat and line transect studied. The shrubs resemble those of open bogs, Aronia arbutifolia and Ilex verticillata, being the most notable species. Betula pumila and Potentilla fruticosa are rare. The shrubs form a vertical layer nearly equal in height to the cedars. The interesting peculiarity of the ground layer is the frequent occurrence of mats of sphagnum (Sphagnum cymbifolium, S. acutifolium) with the round-leafed sundew (Drosera rotundifolia) clinging around the stems of small bushes of huckleberry (Gaylussacia baccata). These hummocks are often overgrown with the prostrate blackberry (Rubus hispidus). Parnassia caroliniana, the fringed gentian (Gentiana circinata), the marsh bellflower (Campanula aparinoides), violets (Viola blanda, V. arenaria) and St. John's wort (Hypericum prolificum) with the great lobelia (Lobelia siphilitica), and a similar but slender dwarf form (Lobelia spicata) are found indiscriminately, but usually near small pools in which the small bladderwort (Utricularia minor), mosses (Hypnums) and Algae (Chara sp.), are some of the frequent species. The cat-tails (Typha latifolia) are still sparse.

Adjoining this open association is a clearing, now used for pasture, which was formerly burned over. The peat soil is black in color, non-fibrous but rather wet. The entire cleared area is densely covered with the shrubby cinquefoil (Potentilla fruticosa) averaging a height between three and four feet. In a few undisturbed places a succession is indicated with arbor vitae as the dominant tree. Seed-

lings of red maple and yellow poplar are close associates. The succession is virtually an indeterminate rejuvenation, that is, the habitat still dominates the formation. The degree of stabilization is still one to give expression to xerophytic forms. The physical conditions are changing extremely slowly, remain unfavorable to invaders, and tend to preserve many of the most important early vegetation stages. The persistence and dominance of the cedar formation in this latitude follows for these reasons, but partly also on account of the predominance of the trees present; for the formation itself must be considered as an essential active factor, in furnishing seeds, and eliminating diversity. Largely, however, the dominance is an adjustment to the available soil water content. A competition with seedlings of deciduous trees other than the yellow poplar and red maple does not seem to ensue although the light relation is favorable. A relation of seed production to ecesis, i. e., to germination and establishment, is nowhere obvious. The various species of deciduous trees have a larger seed production and more effective dissemination contrivances, but so far as the actual number of seedlings is concerned the relative absence of them suggests some edaphic agency in selective operation. There is some sort of correspondence in the arbor vitae, in plasticity of function, or in habitat form, to the life relations of the soil. Definite conclusions, however, can only be reached by experimental studies. The field observations would indicate that the nature of the primeval forest of this region did not consist of a combination of trees such as now exists on the drier areas described above. The deciduous arborescent facies in which the sequence is the development to the deciduous climax forest, is at present decidedly a mixture, and though a closed formation, yet one whose original members were allied more to the northern cedar bogs.

To Miss F. Detmers the writer is under many obligations for aid in the identification of plants.

A FLORISTIC SURVEY OF ORCHARD ISLAND.*

FREDA DETMERS.

In the development of a floristic survey of Buckeye Lake, it has been found advantageous to study in detail the flora, on an ecological basis, of certain typical areas. The banks of the lake are in large part artificial; marshes which have formed in shallow water have been destroyed through dredging, and the earth has been walled up with wood, stone and concrete. These alterations have entirely destroyed the former natural succession of plants, as they have suddenly introduced new edaphic conditions which give rise to new biotic relations. The building of docks and cottages has also largely interfered with the former vegetation. Other areas not thus disturbed remain in much the same condition as that which developed with the formation of the lake.

Orchard or Well's Island is a good example of an undisturbed area and also of one in which changes have taken place. It is one of a group of four wooded islands situated in the southwest portion of the old reservoir and close to the south shore. These islands were elevations in the Big Swamp of which Buckeye Lake is the successor, and were high enough to escape inundation, when the swamp was converted into the reservoir in 1832, and later, when the addition of the new reservoir, in 1836, occasioned the raising of the water level an additional four feet. The highest portions of these islands remain above water at the standard or high water level, which is twenty-three inches above the normal. They bear large forest trees, some of which are twenty-eight inches in diameter.

Orchard island is the largest of these. It has an area of 2.95 acres and is irregular in shape with the longest diameter from the southeast to the northwest. It lies about 200 feet from the south shore of the lake and is connected on the west by a marsh with State Journal Island. The entire surface has been apportioned into lots with an undivided area of common ground at the foot of the public dock, a narrow marginal area, and one in the center of the island. There are now, October, 1910, eight cottages and five docks.

Sixteen years ago Mr. Wells leased the entire island, cleared the center and planted peach trees. His orchard must not have prospered as not one living peach tree remains today. This area is now covered with young forest trees; Ulmus americana, Hicoria minima, H. ovata, Fraxinus nigra, F. americana, Tilia americana, and others

* Contribution from the Botanical Laboratory of Ohio State University, 58.

There is a sparse growth of shrubs, Rubus nigrobaccus, Rhus glabra, R. toxicodendron, Vitis vulpina, etc. The herbage is also poorly developed, it consists of a thin growth of grass and common weeds which have been frequently mowed and in some places burned. A narrow border of larger trees, remnants of the original forest, surrounds this central area. On the south and west this forest border is twenty to thirty feet wide; but to the north and east there is sometimes but a single tree, the lawns extending to the water's edge.

An interrupted zonation of swamp plants occupies the shallow water and the now exposed mud plain surrounding the island. The swamp is well developed on the west, south and southeast, but has been more or less completely cleared away in the vicinity of the docks on the north, northeast and east sides.

This island exhibits a striking example of the invasion of plants into new areas, successful ecesis, the resultant succession, the consequent filling of the lake and the upbuilding of new land areas along the margin; and in the center a secondary succession in a partially denuded area. A detailed floristic study was made of a belt sixty feet broad and extending directly across the island from the southeast to the northwest, from a–a′ to b–b′ on the map. This belt covers a representative area of the island, including a section of the well developed marsh on the southeast, and on the northwest the marsh disturbed and reforming; a section of the older forest zone and of the rejuvenated central area.

There are three distinct formations based on habitat and growth forms:

I. The marsh-herb formation.
II. The swamp-shrub formation.
III. The mesophytic-forest formation.

The first and third formations are well developed, the first exhibits a striking lateral and vertical zonation, the second is so fragmentary that it can scarcely be dignified by the name of formation; but it is of interest as an illustration of the intrusion and development of a zone between two previously existing ones.

I. The marsh-herb formation on the southeast:

1. Nelumbolutea Society.

Facies.

Nelumbo lutea.

Secondary species.

Potamogeton pectinatus.	Potamogeton natans.
Potamogeton var.	Cladophora sp.
Ceratophyllum demersum.	Spirogyra sp.

The society forms a zone 20–40 feet broad. At the outer margin the water is 4–4.5 feet deep at the inner about 8 inches.

In the deeper water it is a pure Nelumbo lutea family; in the shallower, the other plants, especially Potamogeton pectinatus and the variety are quite abundant. There is some evidence of vertical zonation or layering; in the deeper water the Nelumbo leaves float on the surface; and in the shallower rise 12 inches above the surface.

Fig. 1. View of the vegetation from the S. E. side of the island in belt transect a–a′, showing formation I, II and III; and societies 1, 2, 3, 4, 5, 6 and 7 of map.

2. Nelumbo-Polygonum society.

Facies.

Nelumbo lutea.	Polygonum emersum.

Secondary species.

Ceratophyllum demersum.	Brachythecium rivulare.
Spirogyra sp.	Riccia fluitans.
Lemna minor.	Riccia sp.
Cladophora sp.	Ilysanthes gratioloides.
Spirodela polyrhyza.	Sium cicutaefolium.

This society forms a dense zone 60 feet broad, and extends from water 8 inches deep to a wholly emersed surface. 35 feet of the zone covers a mud flat which is submerged at the normal water level. The Polygonum has advanced into the Nelumbo,

forming at the outer margin of the zone as dense a growth as the Nelumbo. Towards the inner margin the Nelumbo is 2 feet tall and fruiting freely.

A short distance west of the belt studied the Polygonum has entirely outdistanced the Nelumbo, replacing society one with a Polygonum zone external to a mixed Polygonum-Nelumbo zone.

Fig. 2. View farther west than Fig. 1. Polygonum emersum forms the outermost zone, then follow zones or societies 2, 3, 4, 5, 6 and 7 of map.

Of the secondary species Brachythecium rivulare is the most abundant, especially on the exposed mud surface, quite large patches of which are covered by a pure growth of the moss. The Riccias are also conspicuous members of the ground cover. The herbs are very sparse.

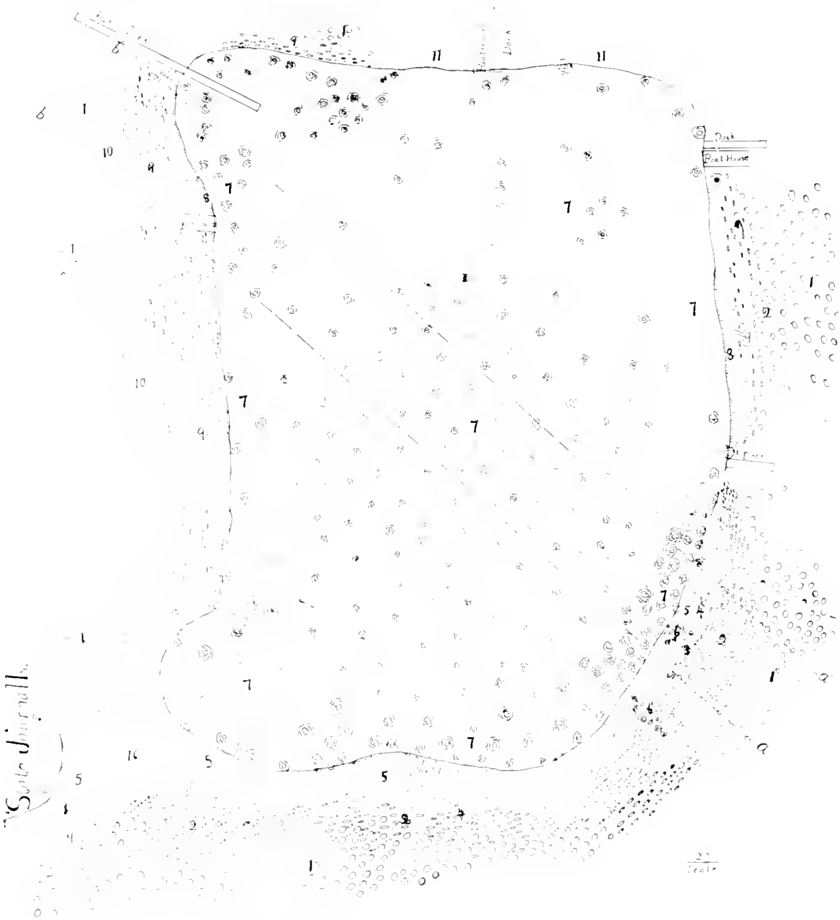
Towards the west of the median line of the belt is

3. A Polygonum-Nelumbo-Typha society.

Facies.

Polygonum emersum.	Typha latifolia.
Nelumbo lutea.	

OHIO NATURALIST. *Plate XI.*



MAP OF ORCHARD ISLAND.

LEGEND OF PLANT SOCIETIES.

1. Nelumbo society,
2. Polygonum-Nelumbo society,
3. Polygonum-Nelumbo-Typha society,
4. Polygonum-Typha-Bidens society,
5. Hibiscus-Typha society,
6. Shrub society,
7. Forest society,
8. Hibiscus society,
9. Polygonum-Scirpus society,
10. Sedge society,
11. Beach without vegetation.

Secondary species.

Spirodela polyrhyza	Cladophora sp.
Lemna minor.	Ceratophyllum demersum.

The secondary species, which are normally floating plants, are stranded on the mud and form but a thin covering. The society covers a narrow lens shaped area not more than 3 feet in its broadest portion. At the normal water level the surface is submerged, but now it is wholly exposed. The Polygonum is tall and vigorous with branches from 3–4 feet tall; the Nelumbo has large erect leaves and the plants are fruiting freely; the Typha is stunted in growth and sterile, the largest leaves are not more than 4 feet tall.

4. Typha-Polygonum-Bidens society.

Facies.

Typha latifolia.	Bidens cernua.
Polygonum emersum	

Secondary species.

Cyperus strigosus.	Cicuta bulbifera.
Eleocharis acicularis.	Bidens frondosa.
Riccia fluitans.	Roripa palustre seedlings.
Riccia sp.	Hibiscus moscheutos seedlings.
Spirodela polyrhyza.	Polygonum emersum seedlings.
Brachythecium rivulare.	

Society 4 occupies a narrow zone less than 3 feet in width. The Typha is larger and more vigorous than in 3, but not fruiting; Polygonum emersum is still conspicuous but not nearly so much as in the preceding zone, while the Nelumbo lutea has entirely disappeared and Bidens cernua, represented by a few large vigorous plants, has come in. There are but a few of the taller herbs of the secondary species; but an abundant ground cover of the Cyperus, Riccia and Eleocharis.

This zone merges into:

5. Hibiscus-Typha society.

Facies.

Hibiscus moscheutos	Typha latifolia

Secondary species.

Taller herbs.

Polygonum acre.	Erechtites hieracifolia.
Triadenum virginicum.	Impatiens fulva.
Scutellaria lateriflora.	Galium claytoni.
Cicuta bulbifera.	Epilobium stricta.
Solanum dulcamara.	Boehmeria cylindrica.
Echinochloa walteri.	Agrimonia sp.
Homalocenchrus oryzoides.	Acnida tamariscina.
Aster paniculatus.	

Seedling trees.

Acer rubrum.	Quercus palustris.
Gleditsia triacanthos.	

Ground cover.

Cyperus strigosus, small mat plants.	Spirodela polyrhyza.
Riccia fluitans.	Brachythecium rivulare.
Riccia sp.	Cladophora sp.
Phialea scutula on dead Hibiscus stems.	

This zone is 40 feet wide and the ground surface is entirely above the water, but so recently exposed that the stranded Spirodela and Algae are still green. The Hibiscus roots form small hillocks on which the Spirodela and Algae become stranded and on which the Riccia is very abundant. The taller herbs form a sparse weak growth due to the density of the Hibiscus which forms a 7 foot wall difficult to penetrate. The Typha is confined to the outer portion of the zone and has here obtained optimum conditions of growth, the plants are not copious, but are tall, vigorous and fruiting freely.

II. Swamp-shrub formation.

6. Cornus society.

Facies.

Cornus stolonifera.

Secondary species.

Rosa carolina.	Hibiscus moscheutos.
Sambucus canadensis.	Solanum dulcamara.
Micrampeles lobata.	Homalocenchrus oryzoides.
Polygonum acre.	Galium claytoni.
Erechtites hieracifolia.	Carex lupulina.
Scutellaria lateriflora.	Convolvulus sepium.
Mentha canadensis.	Ulmus americana.

This society consists of nine Cornus stolonifera in the section studied and occupies an area 20 feet broad. About 10 feet to the west is another Cornus stolonifera far down into the Hibiscus-Typha zone; and about 40 feet still farther west is a group of 15–18 feet tall Cephalanthus occidentalis which extends through the Hibiscus zone to the water's edge. Just east of the eastern margin of the transect is another group of Cornus with Sambucus canadensis.

The swamp-shrub formation does not exhibit lateral zonation but alternations as it consists of isolated shrub societies of which Cornus stolonifera is the principal species in one and Cephalanthus occidentalis in another. The associated species are grouped closely around the Cornus, most of the herbs form a sparse growth in the shade of the shrubs and the Micrampeles and Solanum climb over them.

The two bordering formations the marsh-herb on the one side and the forest on the other, merge in the areas between the shrub societies. The presence of seedling Ulmus, Quercus and Gleditsia, in the Hibiscus-Typha society shows clearly that the forest is invading the marsh, and if the higher portion of the mud flat is not again submerged, the shrub zone may never become more complete than it is now; it may be formed farther down on the shore or it may be entirely replaced by the forest. The incompleteness of the shrub zone is due to the existence of the forest prior to the development of the marsh.

III. Mesophytic-forest formation.

7. Ulmus-Fraxinus society.

Facies.

Ulmus americana.
Fraxinus americana.

Secondary species.

Trees.

Fraxinus nigra.
Hicoria ovata.
Hicoria minima.
Ulmus fulva.
Quercus palustris.
Celtis occidentalis.
Tilia americana.
Gleditsia triacanthos.
Morus rubra.
Salix nigra.

Lianas.

Rhus toxicodendron.
Vitis vulpina.
Parthenocissus quinquefolia.
Smilax hispida.
Solanum dulcamara.
Dioscorea villosa.

Shrubs.

Cornus stolonifera.
Rubus nigrobaccus.
Rubus occidentalis.
Rosa carolina.
Cephalanthus occidentalis.

Herbs.

Muhlenbergia diffusa.
Agrostis perennans.
Syntherisma sanguinalis.
Syntherisma linearis.
Chaetochloa glauca.
Carex tribuloides.
Carex vulpinoidea.
Carex frankii.
Rynchospora alba.
Solidago canadensis.
Aster paniculatus.
Aster sagittatum.
Nepeta cataria.
Teucrium canadense.
Carduus lanceolatus.
Arctium minus.
Helianthus decapetalus.
Urtica gracillima.
Erigeron canadensis.
Hedeoma puligioides.
Mentha canadensis.
Lycopus americanus.
Oxalis stricta.
Onagra biennis.
Solanum nigrum.
Epilobium strictum.
Verbena urticifolia.
Rumex obtusa.
Geum canadense.
Meibomia viridiflora.
Eupatorium ageratoides.
Eupatorium purpureum.
Bidens bipinnata.

Fungi.

Agaricus campestris.
Lycoperdon wrightii.

The forest formation extends across the island from margin to margin and presents two distinct zones: 1. A border zone 20–50 feet wide, consisting in part of large trees, the remnant of the original forest. It is a very open border, not more than three trees deep, the tallest of these trees having attained a height of 60–65 feet. The shrub stratum is very poorly developed. It is represented on the south side by a few Cornus, Rosa and Cephalanthus, at the outer margin of the zone; these are wanting on the north side. The field stratum is composed almost wholly of grasses of which Muhlenbergia diffusa, Agrostis perennans and Syntherisma sanguinalis and linearis are the principal species. Associated with these is a scanty growth of herbs; and on the south side an abundant growth of Rhus toxicodendron, Parthenocissus quinquefolia and Vitis vulpina, trailing over the ground. The Rhus has also climbed two Ulmus americana. The grass and weeds have been mowed, so that the shrubs too are kept in a stunted condition.

Surrounded by the older forest zone lies a rejuvenated area clothed with young forest trees, among which Ulmus Americana predominates, fully nine-tenths of the trees are of this species. This is a part of the area which was cleared sixteen years ago; but the forest has again invaded the area and become established. The ground slopes gently toward the southeast and more abruptly toward the northwest. The elevation of the highest portion is not more than 4 or 5 feet above the standard water level. The gentle slope and the thin shade of the young trees, together with the loose light soil, provide a dry sunny habitat on which Carduus, Aster, Arctium, Hedeoma, Nepeta, Erigeron and other sun loving plants find a congenial environment. There were the remains of large Burdocks and large Rubus nigrobaccus canes. There are scarcely any grasses in this central area; and as it has been mowed and burned all the herbage is scanty.

On the northwest margin of the transect the forest formation is followed immediately by the marsh-herb formation. The marsh-shrub formation is wanting. The marsh-herb formation is represented by four societies:

8. Hibiscus moscheutos society,
9. Polygonum-Scirpus society,
10. Scirpus lacustris society, and
11. Nelumbo-Potamogeton society, none of which shows the development of the marsh zones on the south side.

8. Hibiscus moscheutos society.

Facies.

Hibiscus moscheutos.

Secondary species.

Hypericum mutilum.	Bidens cernua.
Impatiens fulva.	Xanthium canadense.
Hedeoma puligioides.	Rosa carolina.
Panicum walteri.	

The society forms a narrow interrupted border, not more than 4 feet wide of mature fruiting but not tall Hibiscus moscheutos. Of the secondary species the Hypericum is quite abundant at the outer margin of the eastern portion of the zone. The other species are very sparse, of the Xanthium and Rosa there is but a single plant.

9. Polygonum-Scirpus society.

Facies.

Polygonum emersum.
Scirpus fluviatilis.

Secondary species.

Typha latifolia.
Cyperus strigosus.
Ilysanthes gratioloides.
Hypericum mutilum.
Polygonum pennsylvanicum.
Polygonum acre.
Agrostis perennans.
Gratiola virginiana.
Erechtites hieracifolia.
Echinochloa walteri.
Eupatorium purpureum.
Roripa palustris.
Roripa americana.
Alisma plantago.
Amaranthus hybridus.
Arctium minus.
Acer rubrum seedling.
Ulmus americana seedling.
Hibiscus moscheutos seedlings.
Cladophora sp.
Scirpus lacustris.

This society is 40 feet wide, with the entire surface exposed at the present low water level. Hence the extremely heterogenous collection of plants among the secondary species. Dead Typha latifolia stalks are so abundant in the western portion of the zone as to warrant considering it a dominant plant; but the Typha is not at all abundant in the eastern portion of the zone. Arctium minus and Alisma plantago growing close together illustrates strikingly the submerged and emersed stages of the society and the rapidity with which a new habitat is adopted by plants. That the ground has been recently exposed is evidenced by the fresh masses of Cladophora.

10. Scirpus lacustris society. This is a fringing zone 40 feet wide and extending only about half way across the belt, the surface is partly emersed. There is a 20 foot wide sandy beach scantily clothed with the Scirpus.

Secondary species.

Potamogeton natans.
Potamogeton pectinatus
Potamogeton sp.
Nelumbo lutea.

11. Nelumbo lutea society. A small bed of Nelumbo lutea borders the Scirpus lacustris society to the N. N. E. The leaves are but few and widely scattered.

Fifteen feet east of the belt is a public dock, 4 feet wide and extending 78 feet out into the water and 54 feet up onto the shore. The marsh zones are not formed immediately on either side of the dock. On the upper portion of the beach close to the dock, the

Hibiscus zone is coming in. Twenty feet east of the western margin of the belt the marsh zones are interrupted by a boat-house on the beach with a runway for boats extending into deeper water. The development of the marsh formations on the north side has thus been interfered with; and the margin is also more exposed to storm winds and waves. A sandy beach 60 feet wide is building; it is occupied in part by the Polygonum-Scirpus and in part by the Scirpus lacustris zone.

At the south end of the section studied both lateral zonation and layering (etagen) are strikingly shown. There is a marked increase in elevation from one lateral zone to another, from the floating Nelumbo leaves to the tall Ulmus americana and Quercus palustris. This is well shown in the photographs. There is a poor development of etagen in the individual associations. In some there are the dominant plants and then the ground cover, in others a weak irregular growth of taller herbs, while in the forest the shrubs have either been cut or are young plants, and the vines generally trail over the ground.

I wish to take this opportunity of expressing my appreciation of and thanks for the favors shown me by Dr. Alfred Dachnowski, under whose supervision the survey was made, to Mr. Lionel King for the two excellent photographs and to Mr. Booton and Mr. Sawyer of the State Canal Commission for the map and information concerning the acreage and history of Orchard Island.

AN OPEN VALLEY NEAR HARRISBURG, OHIO.*

R. H. NICHOLS,

The subject under investigation is an open valley near Harrisburg, Ohio, on the B. & O. Railroad about fifteen miles southwest from Columbus. This valley at one end joins Big Darby valley near Harrisburg; at the other end after a circuitous course of about three miles on the west side of the creek it again joins Big Darby.

About a mile from the north end the water parts at present on a divide (see map) consisting of two small alluvial fans. The topographic map shows a small stream entering the valley at the divide from the west and flowing northward through the valley, but today this stream is buried in a tile drain and no stream nor channel can be found in this part except a very short one at the end of the valley.

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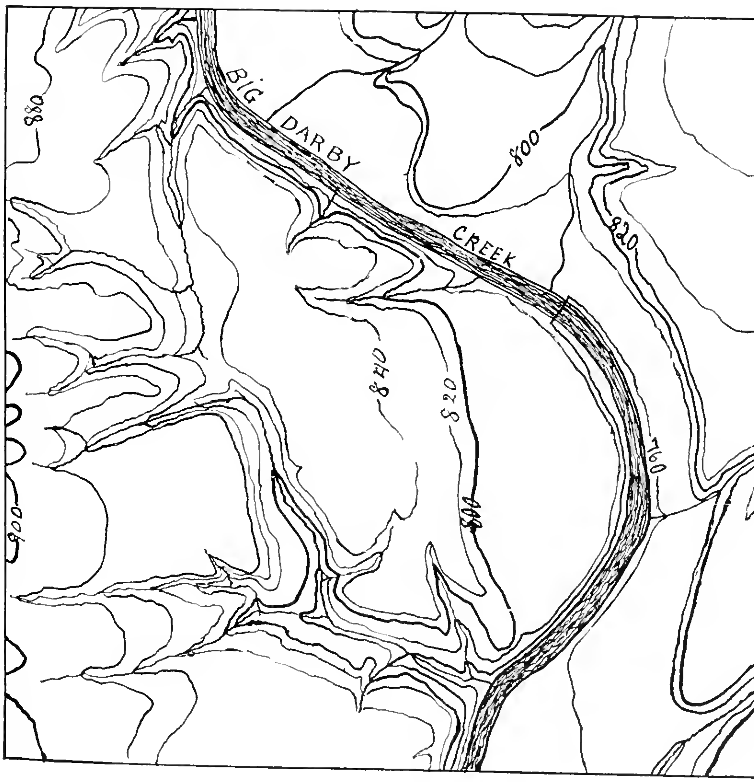
* This paper covers a field problem worked out as a part of the course in Advanced Physiography given by Dr. George D. Hubbard at Ohio State University.

The southern part of the valley has a considerable stream, which in its lower course has cut deeply into the valley floor; leaving the old stream level as terraces above the present bed. The terraces at their down stream end are twenty-five to fifty feet above the present stream level but run out up stream. Similar terraces occur along the Big Darby, but in a number of instances the topographer in making the map has overlooked them, leaving them either on a level with the till plain; or, as in the case where this stream comes out to the Darby on the level with the flood plain.



When one first enters this through valley he is struck by its size in proportion to the size of the present streams in it. Three facts lead him to believe that the present streams could not have carved the valley. First, these little streams would have needed

much more time than post-glacial time. Second, they do not act like the Big Darby and other streams in the neighborhood. As a general thing a stream here swings from one side to the other and undercuts the bluffs; but not so with this one. The third fact is, that the present streams are out of harmony with the size of the valley. These facts suggest that the present streams may have had little part in the formation of the valley, but are only the result of the present local rainfall. Did this region then at some previous period have a larger rainfall? And has the rainfall become less and so reduced the size of the stream? In answer to these questions it should be pointed out that other streams in the vicinity should show the same phenomenon. No such lack of harmony in size is found in any of the nearby streams. Thus we are forced to the conclusion that the valley was formed by other means than that of the present streams or the same enlarged by heavier precipitation.

Since the theory that the valley has been made by its present occupants seems to be untenable another hypothesis is proposed for its origin, namely, that it has been formed by the ice. At first this explanation looked very plausible but when one recalls that the surrounding country is a till plain from fifty to sixty feet higher than the valley floor one wonders why the ice in this particular course cut a deep channel and left the surrounding till plain smooth. We are unable to give a satisfactory answer to this question. Further, if the ice carved the valley it seems at least probable that the Darby would have used the ready-made channel.

There are several points which seem to indicate that the valley is really a stream valley even if the present streams did not produce it. These points may be summarized as follows: (1) The valley floor is nearly level across from one side to the other as all stream-made valleys are and not U-shaped like ice-made valleys. (2) The valley slopes are well graded and rounded at the top into the upland plain on either side which would not be the case in an ice-made valley. (3) A more certain proof that it is a stream-made valley is that its floor is composed of fine silt with no admixture of rocks. If it were an ice-made valley the floor of the valley would be of characteristic drift. Thus it appears that it is not made by ice but by a stream and that the streams found in it at present are not responsible for its formation.

There is a small stream entering this valley near its northern entrance to the Darby which possibly might have been responsible for this valley. This stream comes in from the west and cuts across the northern end of the valley and flows into the Darby through the valley's entrance into the same. But investigation shows that this stream is entirely too small to have been responsible for such a valley. A stream to have cut this valley must have

a larger valley and a broader valley floor upstream than has this little stream in question. Thus we conclude that it must have been made by a much larger and longer stream.

Another theory is that the Darby itself flowed through this valley at one stage of its development, and later changed its course for the present one. But the question arises, if the Darby had this valley for its course in some period of its history, why is the valley so much smaller than the present Darby valley? The Darby valley is from a quarter to one-half mile or even more in width, while the open valley is only one-eighth of a mile in width. Again, the Darby for many miles farther up its course has a much wider valley than this open valley. This width of the Darby valley north of the point where the open valley enters, opposes the idea that the river in some period of its history flowed through the open valley. So we must abandon that theory.

A further solution is proposed, namely, that at an early period in its history, perhaps while still under the ice, the Darby divided its course so that about one-third or one-fourth of its waters went through this present open valley, while the greater portion of the river flowed in its present channel. After time enough to make this valley, the eastern branch succeeded in cutting below the western and thus captured its waters. The open valley was thereby left as an abandoned channel of a portion of the Darby. The floor of this open valley at the point where it joins the Darby is about forty feet above the present level of the flood plain of the Darby. This shows how the Darby in its eastern branch was able to take the waters of the western branch.

These open valleys occur along the Scioto River in several places in its course and are attributed to the same cause as the one along the Darby. The division of the streams sometimes, no doubt, took place under the ice sheet during its last stages. Sometimes an island may have been the cause, separating the stream into parts and causing it to find two separate courses. In such cases the inter-stream area should be sandy.

This Big Darby valley has been abandoned long enough for the present northward stream to have graded a slope for its entrance into the Darby while the stream following southward down the slope once led by the old stream now has in its lower course a considerable flood plain some thirty or forty feet below the abandoned valley floor, leaving the old flood plain beautifully terraced as is that of the Darby itself.

SOME ECONOMIC MONOCOTYLS OF OHIO.

G. W. Hood.

The monocotyls are perhaps the most important plants. They include the grass family which is of special consequence to men and animals. The following brief summary includes some of the most important economic monocotyledonous plants that are found in Ohio.

The rhizomes of the Typhaceae are rich in starch and serve as food for man. The pollen is used to adulterate lycopod powder, the heads of flowers serve as torches when dipped in coal oil, and the downy fruit is used to stuff pillows. In many places the leaves are employed for braid work, and they are also used between the staves of barrels, and for chair bottoms.

The young roots and shoots of Typha latifolia are eaten by the Sioux and other Indian tribes, and the leaves used for matting. The Sioux were accustomed to treat smallpox by frying out the fat of the coyote and making a plaster by mixing it with the down of the fruit, which they applied to the pustules of the patient. The pollen is gathered and made into bread and cakes.

The stems of the Sparganiaceae are used for making paper and thatching roofs, while some of the species of the Naiadaceae, particularly the Potamogetons, make a good fertilizer and can be used as food for cattle. Potamogeton natans furnishes food for swine and the tubers are roasted and eaten by man, while P. lucens is employed as a protection for fish hatcheries.

The species of Triglochin belonging to the Scheuchzeriaceae furnish a good tasting greens and the seeds are also used for food.

Among the Alismaceae, the species of Sagittaria produce a good cattle food, while the rhizomes of Sagittaria latifolia are used as human food and are found regularly on the markets in China. They attain the size of a large fist and are called "Wappato." Before using the rhizomes are soaked in water to take out the swampy taste.

The nuts of the American Lotus (Nelumbo lutea) which occur in large numbers in several places in the state are edible, the large kernels having a sweet taste.

The different species of the Vallisneriaceae furnish an excellent food for ducks. The species Philotria canadensis, known as the water pest, is used as a green fertilizer and cattle food.

The family Graminaceae includes probably more economic species than any other found in the state. The stems of Zizania aquatica are used for making joints of barrels intended to hold whisky, and the Chippewa Indians ate the grain for food; while Phalaris canareinsis produces the well known canary seed. Anthox-

anthum odoratum gives a fine sweet scent to new hay, and the large seeds of Milium effusum furnish a fine food for pheasants.

Ammophila arenaria is used to bind the sand on the sea and lake shores. In England this grass is used for mats and basket work, thatching material, and its fiber for making paper, mattings, and agricultural tie bands. The fiber is not used to any extent in the United States. The fiber of Sporobolus cryptandrus is rather too short to be woven but is used to some extent for tying. Mats and baskets are made from Cynosurus cristatus by the peasantry of Ireland. This grass is just being naturalized in Ohio. The species of Festuca are valuable meadow grasses, and the same is true for Lolium perenne. The seeds of Lolium temulentum, sometimes found in wheat, produces poisonous effects on the system, such as headache, drowsiness and vertigo, if ground in the flour. Agropyron repens furnishes a poor pasture grass but if cut when young gives a fairly good fodder. It is used to fasten sand on river banks. The juicy rhizomes and runners are nourishing food for cattle and contain three per cent of sugar, six to eight per cent triticum, a gummy carbohydrate, and are officially known as radix graminis. The extract acts as a solvent upon collections of mucous of the intestinal membranes, and in affections of the intestinal canal. A syrup and even an alcohol is made from it.

The entire stems of Scirpus lacustris one of the Cyperaceae are used for mats and mattings and to make baskets, bee hives and horse collars. Shoes are made from the plant in England and it is used in Denmark when thrashing buckwheat to prevent crushing the grain. The fiber of Eriophorum polystachyon furnishes material from which paper and clothing are made and Eleocharis palustris is especially valued in Holland for making beautiful matting.

Several species of the Araceae are also important. The corms of Arisaema triphyllum are used as a stimulant, diaphoretic, expectorant and irritant, while Spathyema foetida is administered in affections of the respiratory organs, in nervous disorders, rheumatism and dropsical complaints. The dried roots of Acorus calamus are frequently chewed for the relief of dyspepsia and as a stimulant in feeble digestion.

The different species of Lemnaceae are said to purify water. They furnish food for water birds and fishes, being especially good for gold fish.

The Juncaceae include important fiber plants and also excellent paper stock. The fiber of some species is said to make a good substitute for human hair. The fiber of Juncus effusus is employed in making chair bottoms and baskets, while the pith makes a good substitute for candles. J. balticus is used for weaving mats and light baskets.

Some species of the Melanthaceae, notably of Veratrum, have rhizomes from which tincture of veratrum is prepared. V. viride is used as a poison for insects in spraying for all biting forms and Chamaelirium lutium is used as a tonic.

Hamerocallis fulva and species of Lilium in Liliaceae are very showy and ornamental plants. Various species of Allium including the wild onion and garlic are cooked and eaten by the various Indian tribes.

In the Convallariaceae the young stems of Asparagus officianlis are used as food; while the flowers of Convallaria majalis and Trillium grandiflorum are very ornamental. Narcissus pseudo-narcissus in the Amaryllidaceae, is an ornamental plant, and the roots of Dioscorea villosa in the Dioscoreaceae furnishes a medicine which possesses expectorant properties and promotes perspiration. The Iridaceae give some important species of which Iris versicolor possesses medicinal and ornamental values. It is regarded as an alternative diuretic and purgative. The species of Sisyrinchium are used as ornamental plants.

Some of the Orchidaceae are important, particularly the orchids which are used for medicine and for ornamental plants. Species of Cypripedium yield a medicine used as an antispasmodic and nerve tonic.

MEETING OF THE BIOLOGICAL CLUB.

ORTON HALL, May 9, 1910.

The Club was called to order by the President, and the minutes of the previous meeting read, and approved.

Miss Elsa Leue, and Mr. J. G. George were elected to membership. Prof. F. R. Marshall then spoke to the Club upon the subject, "Breed Records in the Study of Inheritance." Mr. Marshall showed that the keeping of such records is quite important, and that interesting facts may be deduced from them. He gave a brief account of the system of registration of breed stock.

The Secretary read a brief history of the Biological Club, from the time of its organization in 1888 to 1900.

M. G. DICKEY, Sec.

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A HISTOLOGICAL STUDY OF THE SELF-DIVIDING LAMINAE OF CERTAIN KELPS.*

BERTRAM W. WELLS.

Among the brown algae the family Laminariaceae or the kelps, besides comprising the largest species of algae, display in many other ways peculiarities of extreme interest. One of these is a novel and unusual method of branching, exhibited by several of the genera, a character which has caused them to be placed in a sub-family, the Lessoneatae. In this group branches are formed, not as outgrowths from the growing point, which in all the kelps is intercalated between the stipe and blade, but by the formation of a perforation through the growing region, which upon elongation divides the lamina and to a greater or less extent, the stipe also. Taking Nereocystis as typical of the subfamily, a glance at Fig. 1 will make clear this peculiar branching habit. The figure shows a very young plant in which the primary split has divided the original blade and secondary splits are seen fairly started. In Nereocystis lines of modified tissue are always seen running out in advance of the splits. These appear even before the basal perforation is developed, as seen in Fig. 1, b. The repetition of this process of division goes on until hundreds of laminae are found attached to the basal bladder by a system of branching more or less dichotomous in character.

A few writers on the Lessoneatae have given some attention to the histological processes involved in developing the fissures. MacMillan (1899) in his observations on Nereocystis gives a

* Contribution from the Botanical Laboratory of the Ohio State University, 59.

paragraph to the dividing of the lamina, in which he says: "I have been able to determine the origin and nature of the cleft. A single row of cortical cells immediately below the epidermis deliquesces or collapses and the epidermis furrows along the depression. The delequescence is propagated to adjacent cells, right and left, and continues down the middle lamella. The furrowing may take place along one surface of the leaf or along both surfaces until the epidermal cells come to lie against the middle lamella. The latter then breaks down and the two epidermises are contiguous. The split takes place along the base of the furrow and leaves the two halves of the lamina with apparently normal unwounded edges. * * * * The epidermis suffers no disintegration during the process. * * * * The furrow of the epidermis seems to deepen destroying the inner cells of the lamina as it progresses." In other accounts the central idea has likewise been an association of a process of cell disintegration or gelatinization with the inception and advance of the split. Rosenthal (1890) in his discussion of Macrocystis holds that the inception of the split occurs as a parting of the superficial layers, which is eventually followed by a swelling or gelatinization (quellungen) of the pith-web. In this modified pith-web a cavity is formed, which, enlarging, finally meets the gaps already developed in the upper layers and the lamina is divided. No discussion of the origin of either the inner cavity or superficial clefts was given. Reinke (1903) writing on Macrocystis gives Will's (1897) account of the splitting process, which account is also confirmed by Skottsberg (1907). The fissure occurs by the formation of an elongated cavity filled with a jelly-like substance, arising through gelatinization of the inner tissues. The furrow or depression which precedes the cleft is formed by a sinking or pushing in of the epidermis due to increased division of the cells overlying the gelatinized portion.

Because of the brief and fragmentary nature of the accounts heretofore given, it was believed that a fuller investigation of the matter would be desirable. Further it was thought important to make a comparative study of the splitting processes in the different genera available, in three of which, Postelsia, Lessoniopsis and Dictyoneuron, these processes have heretofore never been described. Material for the five genera investigated was in the collection of Prof. Robert F. Griggs of the Ohio State University, to whom I am greatly indebted, not only for material, but for much valuable advice and criticism throughout the course of the study. In view of the diversity found between the different genera, it would be very interesting to study Lessonia and Pelagophycus also, but material of these genera could not be obtained.

A part of the plants studied were killed in chrome-acetic acid and part in formalin. The usual methods of microtomy were

followed; paraffine forming the embedding medium and the sections cut 10 mic. thick. The single stain aniline safranin or the same in combination with gentian violet were used. The first stain gives the middle lamella of gelatinous interlacing food conducting hyphae a characteristic tint which is of much value in distinguishing it from the adjacent cortex. All drawings were made with the camera lucida.

To understand the splitting of the kelp lamina and its relation to the tissues through which it passes, a digression must be made to set forth the manner of growth in the kelps, with special consideration of the derivation of the tissues. Three systems of tissues make up the kelp thallus: the epidermis, the underlying cortex and the central pith-web. Sections of stipe or lamina show the hypha-like elements of the pith-web to be highly stretched and modified cortex cells and the cortex cells are clearly seen to be derived from the epidermal cells, which form therefore the meristem in these plants. By periclinal walls the epidermal cells build the cortex; by anticlinal ones the epidermal area is enlarged. Hypodermal and outer cortical cells are often seen dividing, but the total meristematic activity of these internal cells is not nearly so great as that of the epidermal cells. The cells pushed inward from the epidermis reach their maximum size in the middle cortex. On the outside of this expanding cortical zone, the epidermis correspondingly enlarges its area by a constant increase in the number of its relatively smaller cells; the division walls of course being anticlinal. On the inner side of the expanding cortical zone the passive pith-web is seen to consist of much elongated cortical cells (trumpet hyphae) between which are large intercellular spaces filled with a gelatinous matrix. By this method the large and complex kelp thallus originates and the various structures peculiar to the several genera, including the method of branching under discussion, have their origin in variations of this simple process.

NEREOCYSTIS.

Nereocystis with its prominent splitting line extending far in advance of the cleft, forms an especially favorable type for study as portions of the lamina through which the line passed could be successively investigated down to the actual fissure and the various stages of the process clearly observed. Fig. 2 shows a section through the splitting line at a point corresponding to Fig. 1, a. The changes from normal lamina are at once seen to be a diminution in the thickness of cortex and pith-web, resulting externally in the formation of a broad furrow on each side. A comparison of the affected region with that of normal lamina at either side, discloses the fact that in the middle region the ratio of periclinal divisions to anticlinal ones has increased as is evi-

denced by the increased number of pith-web elements, together with the incipient cell rows from which they were derived. The unusual number of cortex cells formed rapidly stretches and attenuates the pith-web and inner cortex until the original medulla, locally, has been almost replaced by the newer and but slightly modified cortical elements. Fig. 3 illustrates the process in a more striking manner. This as well as the remaining figures are of the same magnification. At this stage periclinal divisions have been so rapid that small ridges have been formed in the middle of each broad furrow. The enlarging inner cells give the cortical structure a fan-like aspect. The inner cortical cells in the middle region pass into the middle layer before they reach their maximum size due to the rapid development of the cells over them. This accounts for the local massed condition of the medulla in the splitting region, causing the dark splitting line when the blade is viewed by transmitted light. The final result of all this activity is the intercalation of a region, made up entirely of new tissue, which has no strength to resist wave action and is easily torn apart. Fig. 4 shows the lamina at the critical point with the tear partly through it. The inner cortex cells of the preceding figure have passed into the middle layer condition and the lamina is markedly reduced in thickness. When severely whipped the laminae are often ripped at their distal ends; the tear if of any depth always following the weakened zone of the splitting line (Fig. 1.)

The wounds formed are shown in Fig. 5 which in the serial sections was taken from the same slide as Fig. 4. By normal activity the epidermis and cortex are built out and around the exposed part of the medulla (Fig. 6), finally coming in contact (Figs. 7-8). Generally the two epidermal layers do not exactly meet and the edges of the new laminae show a scar in section. Subsequent to the healing, the cells of the inner cortex, overlying the edge of the middle layer, do not develop to normal size but become sclerenchymatized (Fig. 8). Growth above presses them inward, noticeably bending the hyphae of the middle layer. This condition disappears later when the thick walled cortical elements pass over to the medulla.

This method of splitting was observed in several specimens but in no instance was any deliquescence or cell disintegration observed as reported by MacMillan in his observations on this plant.

POSTELSIA

Postelsia and the other Lessoneatae differ from Nereocystis in the absence of a long splitting line formed in front of the actual cleft. A close inspection shows, however, the presence of a very short line indicating that the modification of the inner tissues is not begun until the fissure is very near. But for the most part the

tissue changes involved are confined to the region immediately around the advancing fissure.

The splitting process in Postelsia cannot be correlated with that of Nereocystis. Instead of a mass of new tissue being formed by periclinal activity, there obtains a relative lessening or inhibition of all cell division, while the modification of the various cells in the dividing region into cortex and pith-web continues unabated. Thus the lamina locally becomes thinner and thinner until the critical point is reached. Fig. 9 shows a normal portion of a lamina at one side of the splitting region. The epidermal and hypodermal cells are markedly elongated perpendicular to the surface; the larger middle cortex cells have their usual isodiametrical form and the inner cortex and pith-web are stretched horizontal to the surface. Contrasting with this is Fig. 10 from the middle of the furrow on the same section as Fig. 9. Here the large cortical cells have become prematurely elements of the middle layer and even the outer cortical elements show evidence of horizontal stretching due to the expansion of the superficial layers, while there are few divisions in the epidermis.

This lack of meristematic activity fails to build out the lamina to the normal thickness as shown in Fig. 9, and reduction in thickness continues progressively as the cortical cells are stretched into the weak and yielding pith-web elements. In Fig. 11 the lamina is shown at the critical point where ripping apart may occur. The cortex has practically disappeared. The development of the remaining hypodermal cells has parted the inactive epidermis on each side and the lamina is now in condition to be torn apart by the slightest twist. Throughout the entire process of reduction to the critical point no cell gelatinization occurred. After fission the wounds are healed exactly as in Nereocystis, by activity of the adjacent epidermal cells building tissue out and around the exposed edge of the medulla.

LESSONIOPSIS.

The lamina of Lessoniopsis is characterized by a thickened mid-rib made up chiefly of sclerenchymatized cortex. Upon division the reduction of the lamina to the critical point may be divided into two rather definite stages. In the first place as seen in the development of the perforation, broad furrows are formed in the basal portion of the mid-rib, resulting in the intercalation here of a small area of normal undifferentiated lamina. Then through this, rather than through the mid-rib proper, the cleft is propagated. These two stages are more sharply differentiated in the case of older and advancing splits, for here the portions of the divided normal lamina or the reduced mid-rib retain their thin blade-like character and broaden out until the daughter laminae are symmetrical and the mid-ribs occupy their normal median position.

The origin of the primary shallow furrows is different from anything seen in either of the preceding genera. In Lessoniopsis the relative increase in anticlinal activity in the epidermis seems to be the factor operative in reducing the thickness of the cortical layers. The undue stress brought to bear on the cortex by the rapidly expanding superficial layer results in the premature transition of the inner and middle cortex to the pith-web condition. Ordinarily expansion at the surface in inanimate objects results in buckling. In this case the transmission of the stress to the inner cortical layers stretches their elements into the thinner or highly elongated pith-web condition, thus markedly lowering the upper layers so as to produce concavity instead of convexity at the surface. No figure is given to illustrate this condition as the area concerned was far too extensive to be drawn on a scale sufficiently large to show the histological changes.

The second stage or splitting proper is by a process as different from that observed in Postelsia as that is different from Nereocystis. The central part of the mid-rib, after its reduction to the thickness of ordinary lamina, is locally still further reduced by the action of an internal cortical meristem, associated with a quiescent epidermis. On both sides of the medulla in the region concerned the cortical cells are seen dividing with anticlinal walls (Fig. 12). This has resulted not only in severely attenuating the pith-web but on one side the epidermis itself has parted and the critical point has been reached, for the thin-walled cells of this newly formed tissue cannot withstand the ripping tendencies in the wave swayed and twisted lamina. At approximately the same stage or on the same slide from which the drawing was made, the lamina portions were already separated.

In healing, the wounds first are covered for a time with a callus formation but later the epidermis and cortex heal them over exactly as in Nereocystis.

MACROCYSTIS.

The splitting process in this genus was studied by the German writers already quoted, but they evidently confined their attention to the development of the original perforation and did not study the elongation of the cleft, which is carried out by a different process than that forming the perforation. This fact at once sets Macrocystis apart from the preceding genera in which the processes originating the perforation are also operative in elongating the cleft. Sufficient material was available showing the incipient and older splits, to make four or five series of sections illustrating each of these stages. Part of the material studied came from the ·ruvian coast, part from Vancouver's Island. Small and large venile laminae, having splits in about the same stage of develop-

ment, were used to determine whether the splitting process varied in any way with the size of the Lamina.

The writer is able to confirm in part Will's account of the origin of the basal perforation. Broad shallow furrows appear on either side of the thallus. These depressions may arise as in Nereocystis by a relative lessening of anticlinal divisions, but the area concerned is so extensive and the slightly constricted portion passes so gradually into the normal lamina, that no marked difference of tissue structure could be observed. After these shallow depressions become well defined, another and wholly different process is inaugurated. The inner cortical cells lying under the base of each furrow become gelatinized. A single cell disintegrates followed by its immediate neighbors until all the heavy walled cortex under the central part of the furrow has disappeared. Associated with this process of gelatinization is a marked local deepening of the furrows at their central parts (Fig. 13-14.) Will states that this originates by a pushing in of the epidermis due to increased division of the cells over the gelatinized portion. The evidence for this does not appear conclusive as can be seen by comparing the size of the hypodermal cells beneath the furrow with those on either side. The cells lying in the base of the furrow (Fig. 14) give evidence of relative inactivity, showing a diminution in anticlinal and especially periclinal divisions. To the lessening of periclinal activity chiefly, can be ascribed the origin of the more sharply defined secondary furrow, for the epidermal cells in this region fail to build out the thallus. This is somewhat similar to the condition in Postelsia. At about the stage figured normal growth begins to close in on the gelatinized cavity separating schizogenetically the remaining cortical cells underlying the furrow. The usual gelatin filled pith-web together with the newly gelatinized regions of the cortex forms a sort of internal cavity or wound which is healed by a process identical with that seen in Nereocystis (Fig. 15). Here normal development is bringing the respective sides around the edges of the middle layers. The remnant of one of the gelatinized portions is still present, stretched across below the furrow.

After the original basal perforation is formed in the manner just described its advance through the lamina is by a wholly different process. Unexpected as this might seem the evidence for it is quite conclusive. Fully formed splits 5 mm. in length and upward were studied, occurring in laminae of different size and thickness and from different waters, British Columbia and Peru, but in no case was there any deviation in the process.

Local and excessive meristematic activity of the cortex is the fundamental factor in the advancing cleft. First, however, there is a local increase in the normal growth process which results in piling up slightly modified cortical cells in the medulla. Next

a few hypodermal and outer cortical cells begin to divide rapidly forming a wedge-like mass, which tears the epidermis apart and the process which succeeds in dividing the lamina is begun (Fig. 16.) The cells exposed by the parting of the epidermis become passive and subject to the tearing tendencies of the rapidly expanding tissue beneath them. They are separated and in this manner the cleft is carried clear through the lamina. So great is the meristematic activity that before the cleft reaches the pith-web this layer locally has been entirely replaced by dividing cortical elements, through which the cleft is propagated. The final separation of the last thin walled cortical cells is of course mechanical. By the continual extension of this cortical activity distally, the whole lamina is finally divided, while proximally, the separation is carried some distance down the stipe by the same sort of activity except the meristematic wound tissue is formed in larger masses and the cleft advances in a more irregular manner.

In healing, the superficial cells of the exposed wound tissue are transformed into epidermal elements. There is however a tendency to close the wound as previously described, by the crowding or pressing around of the tissue adjacent to it.

Material containing clefts of proper age to show the transition stages, by which the initial gelatinization process gives way to the secondary process of cortical activity, was not available so this nteresting phase of the problem cannot be taken up in the present diiscussion.

DICTYONEURON.

In Dictyoneuron only the method of advance of the older cleft was studied, as the collection contained no material showing the incipient or perforation stages. The process involved in the advance of the cleft was essentially the same as that in Macrocystis but the cortical meristem is more definitely localized than in that genus and only occurs at first on one side of the medulla. Fig. 17 shows a section of a young lamina in which a split .5 mm. in length was present. The half of the section not shown was normal like the region at the edges of the drawing. Cell division and growth in the cortex has resulted in the formation of a mass of tissue which presses slightly into the pith-web. When this mass has become somewhat more extensive than that figured, a few cells near its center begin dividing very rapidly and build up a new secondary mass within the first (Fig. 18), which pushes out the older cells on all sides of it, notably below into the pith-web. On account of this rapid internal division, the original epidermis is pulled apart from a to b and the beginning of the cleft has been started by the wedging action of the ball like mass of new tissue. This cleft shown at Fig. 18, c, next enters the central mass and passes rapidly to its center. After the development of the cleft.

the superficial and hypodermal cells lining the gap divide chiefly with periclinal walls until the newer tissue comes to have a fan-like structure, similar to that seen in Nereocystis (Fig. 19). By the same process described in that plant though on a much larger scale, the furrow is strongly widened and deepened. This results as in Nereocystis not only in attenuating the lamina locally but in filling up the middle region with young cortical tissue (Fig. 20) which has no strength and is easily torn apart by wave action.

After ripping apart the cortical cells exposed from a to b (Fig. 20) take on the aspect of epidermal elements with which is associated a tendency of the contiguous tissues to close around the injured portion. The two lamina edges resulting from the entire process of division are lined with new tissue, the superficial layer of which becomes epidermal in character and remains so. These edges show for some time a groove running in them which is wholly accounted for by the peculiar splitting process obtaining in this plant.

GENERAL CONSIDERATIONS.

That in all cases the split actually progresses through the blade is clearly shown. The exposure of the inner tissues lying just behind the apex of the advancing cleft is evidence enough to prove that the fissure is cleaving the blade and is not a pseudo-cleft brought about by intercalary growth of the portion divided by the perforation. This latter, however, is of much importance in the apparent elongation of the split.

As to the rapidity of advance of the cleft, nothing whatever was determined. It is doubtful that this can be worked out even in the field with any degree of accuracy. The facts of intercalary growth and mechanical ripping would tend to vitiate any measurements that might be made.

In the study of the various genera special attention was given to the advance of the distal end of the split, or the division of the blade. In each genus however observations on the proximal end of the cleft were made, which not only showed that the stipe was dividing, but the splitting process was in each instance identical with that described for the blade. Owing to the thickness and compactness of the stipe the changes in it are much slower than in the blade. The elongation of the stipes is chiefly by intercalary growth.

An arrangement of the five genera on a basis of specialization in the splitting would be as follows: Postelsia, Nereocystis, Lessoniopsis, Macrocystis and Dictyoneuron. The relative arrangement of the first three might be questioned but that the process in Macrocystis and particularly Dictyoneuron is a very definite and specialized one admits of no doubt.

Upon taking up the present investigation, the writer expected to find that the division of the laminae in the different genera, was brought about by the same process with of course some minor variations. It was then very surprising to find the widest differences prevailing among the various genera, differences in some instances so great as to make the histological processes involved appear diametrically opposed. The end result, the branching of the plant, in all cases is the same so we have in these forms a most striking example of those numerous instances in nature in which a common end is attained through totally different means.

SUMMARY.

1. The splitting of the lamina of Nereocystis is due to a relative increase of periclinal divisions resulting in the intercalation of weak new tissue which is mechanically torn apart. The wounds heal by normal growth, building the tissue out and around the exposed edges of the medulla.

2. In Postelsia cell division in the meristematic epidermis ceases almost entirely at the point where splitting is to occur and the lamina becomes so thin by the continued differentiation of the tissue already present that it is torn apart by the impact of the waves. The wounds heal as in Nereocystis.

3. In Lessoniopsis an area within the mid-rib is reduced to the thickness of normal lamina by relative increase of anticlinal divisions. Within this area further reduction and weakening occurs by anticlinal divisions in the cortex. The wounds after mechanical ripping are at first covered with callus; later healing as in Nereocystis.

4. Macrocystis shows the perforation to originate by local gelatinization of the inner and middle cortex and cessation of periclinal activity in the epidermis over the gelatinized portion, resulting in a deep sinus on either side of the lamina. The adjacent tissues are finally forced in on the gelatinized places until the epidermis breaks apart forming the perforation. Healing as in Nereocystis. When once formed the fissure advances by excessive cortical meristematic activity which first tears apart the epidermis and finally the whole lamina, which meanwhile has locally become filled with cortex cells. Healing is by transformation of the exposed cortex into epidermis.

5. In Dictyoneuron only the advance of the cleft was studied. An internal wedge-like mass of tissue, a cortical meristem, tears the overlying layers apart. Periclinal division of the cells lining the gap forms a fan-like structure which reduces the lamina in thickness and strength until mechanical tearing follows. The superficial cells of the new tissue formed on the respective edges are changed to epidermal elements and remain so.

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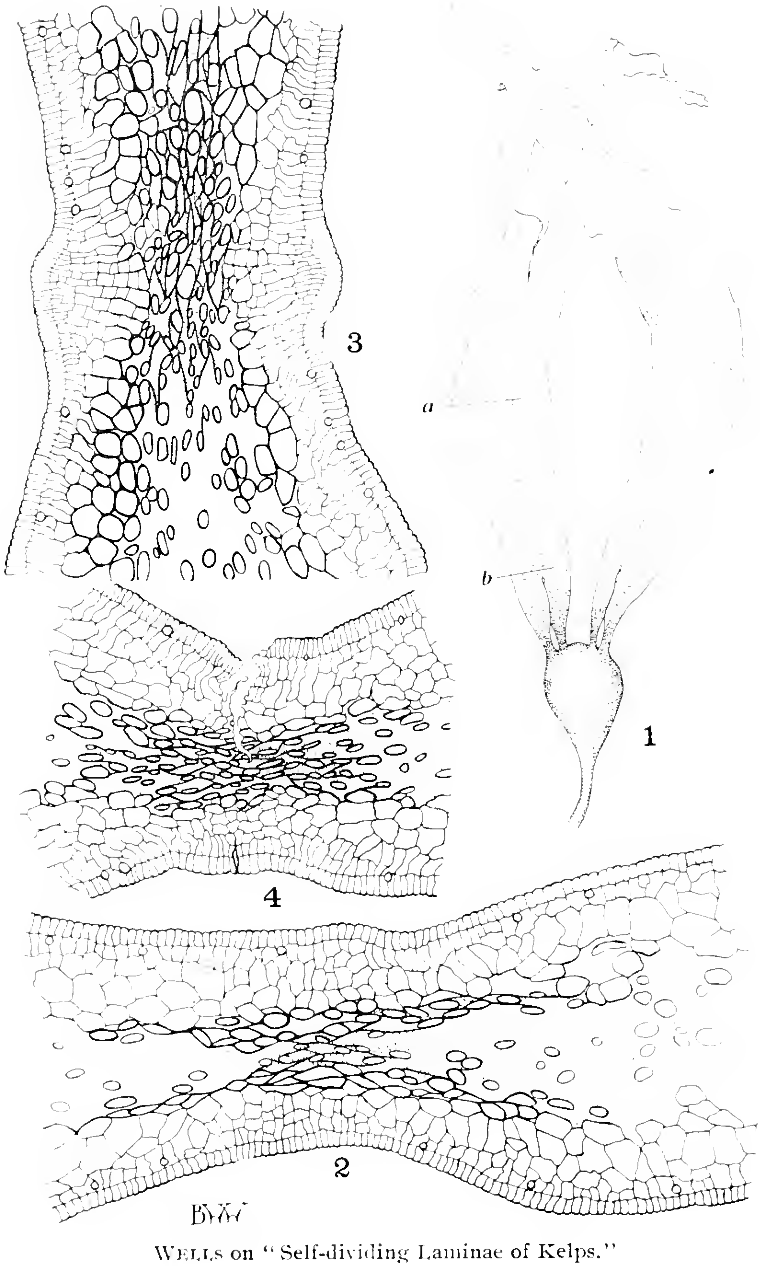
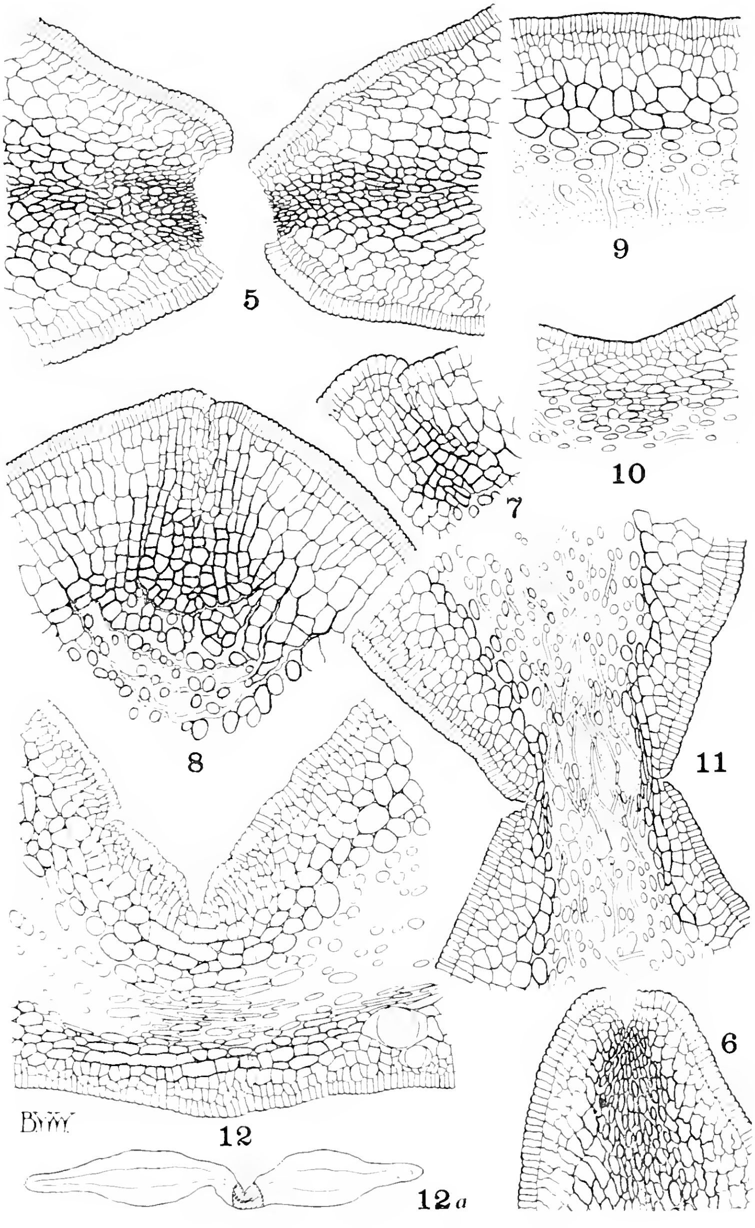
EXPLANATION OF PLATES.

FIG. 1. A Young Nereocystis plant showing splits and splitting lines.
FIG. 2. Cross section of Nereocystis lamina at a point corresponding to to Fig. 1, a.
FIG. 3. Cross section of Nereocystis lamina at a point near end of split corresponding to Fig. 1, b.
FIG. 4. Cross section of Nereocystis lamina showing mechanical tear.
FIG. 5. Cross section of a newly divided lamina of Nereocystis showing wounds.
FIG. 6. Healing lamina of Nereocystis.
FIG. 7. Healing lamina of Nereocystis, later stage.
FIG. 8. Completely healed lamina of Nereocystis.
FIG. 9. Cross section of normal Postelsia lamina.
FIG. 10. Middle stage in splitting Postelsia lamina.
FIG. 11. Final stage in splitting lamina of Postelsia.
FIG. 12. Last stage of splitting in Lessoniopsis.
FIG. 12a. Entire section showing position of Fig. 12.
FIG. 13. Origin of perforation in Macrocystis, middle stage.
FIG. 14. Structure of portion enclosed in dotted line. Fig. 13.
FIG. 15. Final stage in the development of the original perforation in Macrocystis.
FIG. 16. First stage in the advance of the mature cleft in the Macrocystis lamina.
FIG. 17. Primary cortical meristem in splitting region of Dictyoneuron.
FIG. 18. Secondary cortical meristem within the first in Dictyoneuron.
FIG. 19. The cleft and fan shaped structure developed in the splitting of the Dictyoneuron lamina.
FIG. 20. Final stage in the dividing process in Dictyoneuron. Cortical meristem present.



WELLS on "Self-dividing Laminae of Kelps."



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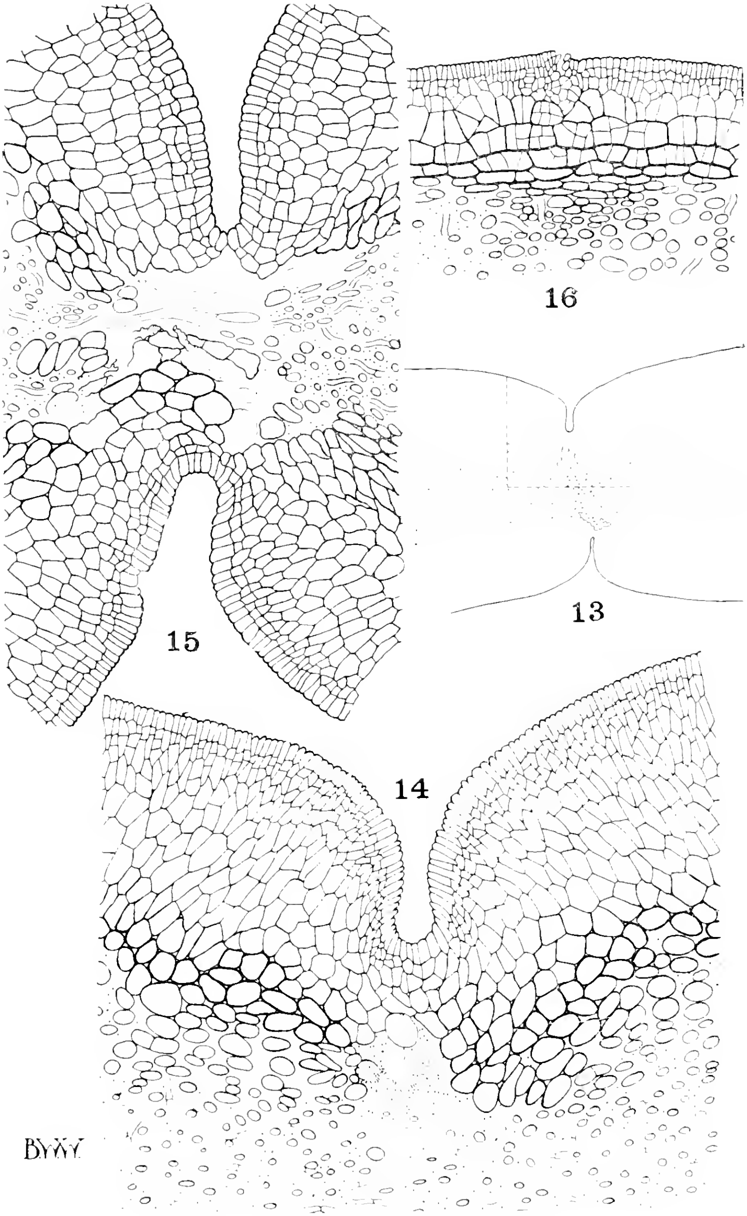

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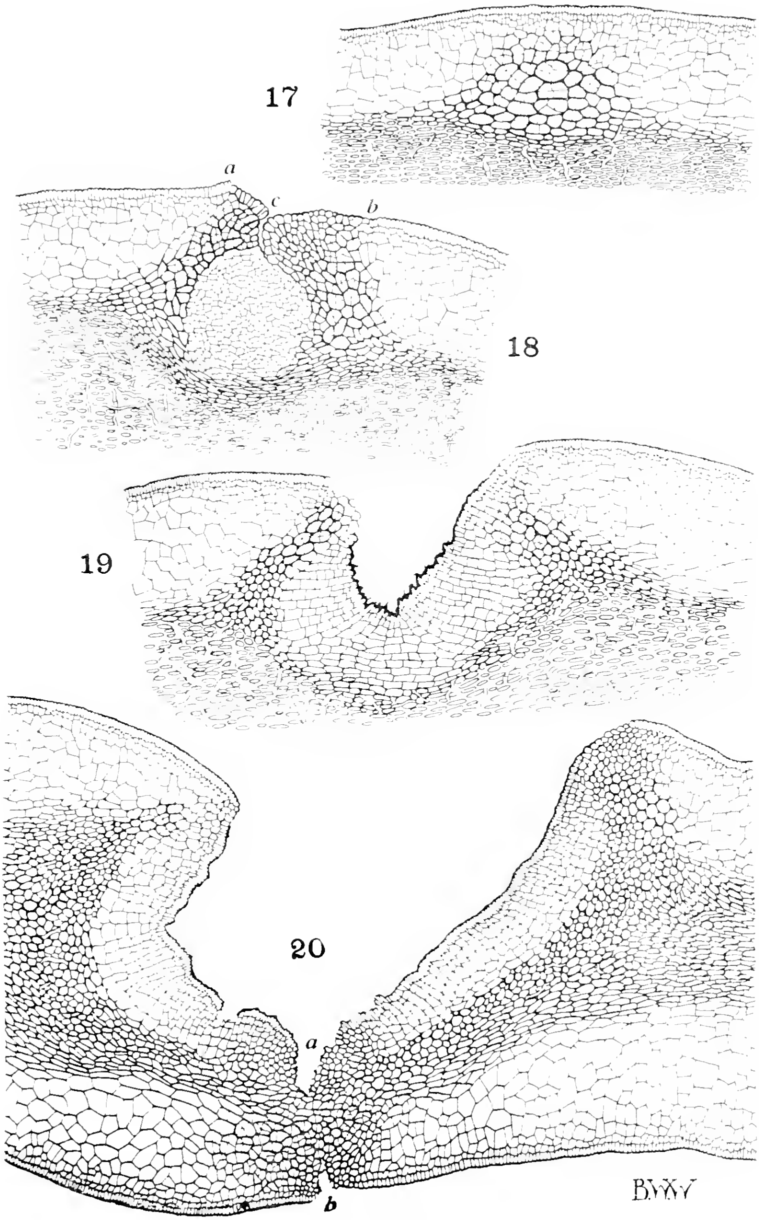

WELLS on "Self-dividing Laminae of Kelps."

VIOLA HIRSUTULA IN OHIO.

ROBERT F. GRIGGS.

Every spring for several years past the writer has observed a blue violet in the vicinity of Sugar Grove to which he was unable to assign a name. But the plant was so common and so clearly distinct from all of the other violets of the region that he supposed that his trouble arose from the difficulty of the genus rather than from any rarity of the plant itself. Finally in 1910 particular care was taken to collect perfect specimens both at flowering time and in early summer and from a study of these it was evident that the plant was Viola hirsutula Brainerd, better known as Viola villosa Walt., but not, according to Brainerd, Walter's plant. This determination has since been verified at the Gray Herbarium. The mature plants are entirely similar to those in the herbarium but those in flower vary somewhat from the usual form in a tendency toward lobing at the base of the leaf which while occasionally seen in the herbarium specimens is sufficiently pronounced in almost all of the Sugar Grove plants to make it difficult to decide which section of the key to follow in their determination. This tendency is confined to the youngest leaves and in mature plants the leaves are all cordate. In addition to the characters given in the manual there is a very distinctive field character which should be included in the descriptions. This is the purple veining of the upper surfaces of the leaves which together with their mottling of different shades of green renders the plants very beautiful for their foliage alone. In the herbarium specimens this color fades and becomes indistinct but in many cases it is still visible and when present is useful for diagnostic purposes.

The hitherto known range of Viola hirsutula is: Southern New York and New Jersey to Florida and Louisiana, both in the mountains and on the coastal plain. The present station is about two hundred miles west of the most westerly locality previously reported, namely in the vicinity of Pittsburgh, where it is reported by Shafer. At Sugar Grove it is exceedingly abundant on the uplands where it occupies much the same place in the plant associations that the common blue violet fills on the bottomlands. It is especially a plant of old fields and pine barrens though it is also to be found along with many other of the upland plants in pastures where the land is more fertile. From the abundance of the species in this region and the widespread occurrence of similar habitats over all of Southeastern Ohio, the writer is led to believe that when once it is recognized by the botanists it will be found growing almost throughout this region.

THE MACRO-LEPIDOPTERA OF SENECA COUNTY, OHIO.

W. F. Henninger.

Through a combination of circumstances, comparatively rich material of the order Lepidoptera has come into my hands, and on this account I am led to prepare the list which follows. It is not claimed that the list contains any species new to entomologists, but it has value in showing the occurrence of certain species in the state.

Louis Ullrich, of Tiffin, collected butterflies and moths for many years. He did not publish much but aided other workers of the country materially, being the first man to obtain a detailed life history of Debis portlandia as well as to add to our knowledge of various other species. His collection at one time numbered fully 22000 specimens, and Spencer F. Baird tried to induce him to donate it to the Smithsonian Institution. Mr. Ullrich followed the profession of a druggist for years, but financial reverses caused him to change and he became a successful florist. After he became prosperous in this new business, I persuaded him to take up work on the Lepidoptera again. He had reached an advanced age, however, and did not live a great while, his death occurring in 1906.

I purchased what was left of his collection, approximately 3000 specimens, 2100 of which were in excellent condition. He had collected ninety species of Geometridae in Seneca County but these were destroyed previously by Dermestes. The collection also contains many species of European and Indian Lepidoptera. The Diurnals were identified by W. H. Edwards, as were some of the others.

A little later a collection of 2000 specimens belonging to Mr. Harry F. Murphy, former secretary of Congressman Jackson, came into my possession. Many of these are of local interest. The 5000 specimens thus obtained are responsible for the data in regard to the rarer species, but some of the more common ones are of my own collecting at odd moments of a busy professional life. Much of my spare time too has been spent in bird study.

For a short description of Seneca County, I refer the reader to the Wilson Bulletin, number 55, page 48.

My thanks are due to Prof. H. Osborn, of Ohio State University, for kind advice, and to Mr. Wm. Kayser, of Wapakoneta, for the use of his fine collection of Lepidoptera for identifying several species. A few of the species collected in Seneca County have not been determined and so are not included in this list.

The nomenclature used for the butterflies is according to Holland, while that used for the moths is after Dyar.

Rhopalocera (Butterflies).

Anosia plexippus. Common. Great flight Oct. 3, 1907.
Euptoieta claudia. Casual. I saw H. F. Murphy capture one on Aug. 27th, 1907, in a clover field. Has been taken at Castalia by D. F. Berrenger, of Fostoria, O.
Argynnis idalia. Rare. 4 taken by L. Ullrich. 1890.
Argynnis cybele. Common. Extremely variable.
Argynnis aphrodite. Not common.
Argynnis aphrodite alcestis. Occasional. L. Ullrich. Whether diana has ever been taken in this county is not ascertained.
Brenthis bellona. Common.
Brenthis myrina. Mr. L. Ullrich has taken it. (ex verbis).
Melitaea harrisii. Mr. L. Ullrich has taken 2 specimens in June, 1890.
Phyciodes nycteis. Not common in April and May.
Phyciodes tharos. Both very common, very variable. One taken.
Phyciodes tharos marcia. Resembling Melitaea hofmanni in markings.
Phyciodes batesi. Rather rare. Taken by Mr. Ullrich.
Grapta interrogationis fabricii. Common.
Grapta interrogationis umbrosa. Common.
Grapta comma harrisii. Common.
Grapta comma dryas. Common.
Grapta progne. Rare. Taken by Ullrich and Murphy both.
Vanessa milberti. Rare. 4 taken by Ullrich (ex verbis).
Vanessa antiopa. Common.
Pyrameis atalanta. Common.
Pyrameis huntera. Common.
Pyrameis cardui. Common.
Junonia coenia. Taken in 1891 by Ullrich and Murphy.
Basilarchia astyanax. Common.
Basilarchia disippus. Common.
Chlorippe celtis. Not common in open woods.
Chlorippe clyton. Fairly common.
Chlorippe clyton prosperina. Several taken.
Debis portlandia. Formerly locally common, now rare.
Satyrodes canthus. Common in swampy meadows.
Neonympha phocion. One spec. taken. This record is doubtful.
Neonympha eurytus. Common in woods.
Neonympha sosybius. One spec. taken by L. Ullrich.
Satyrus nephele. Not common. Taken by L. Ullrich. I have seen this species on the wing in the swamps near the O. S. U. Laboratory at Cedar Point, July 3, 1907.
Libythea bachmani. Rare. Taken by Ullrich and myself.
Thecla calanus, Not common.
Thecla calanus strigosa. Rather rare in woods. Common at New Bremen, Ohio.
Thecla melinus. Fairly common.
Thecla titus. Rare. Several other species of Thecla in the collection were undoubtedly taken at Tiffin, but I omit them owing to the lack of definite data.
Feniseca tarquinius. Rare. 2 spec. taken June, 1891.
Chrysophanus thoe. Common in swampy meadows.
Chrysophanus hypophloeas. Common in swampy meadows.
Lycaena pseudargiolus. Common.
Lycaena pseudargiolus lucia. Rare in early April. Taken by L. Ullrich only.
Lycaena pseudargiolus violacea. Common. Taken by myself April 22, 1906.
Lycaena pseudargiolus neglecta. Not common.

Lycaena comyntas. Common. A dwarf taken by L. Ullrich no larger than exilis.
Pieris protodice. Common.
Pieris protodice vernalis. Common.
Pieris rapae. Commonest fly.
Pieris napi virginiensis. July 6, 1905, I caught one specimen, unfortunately was destroyed later.
Catopsilia eubule. Accidental. One specimen caught Aug., 1890, by L. Ullrich.
Terias nicippe. Rare. Taken by L. Ullrich, April, 1894, April 21, 1896. Seen but not taken by myself, April 22, 1906.
Terias lisa. Common.
Terias lisa alba. Common.
Meganostoma caesonia. Messrs. Ullrich and Murphy both took it years ago at Bascom 6 miles west of Tiffin.
Colias eurytheme. Not common, flies in Sept. and Oct. Two albino females taken.
Colias eurytheme keewaydin. Several taken.
Colias eurytheme ariadne. Several taken. One hybrid between eurytheme and philodice taken 1896.
Colias philodice. Next to Pieris rapae the commonest butterfly. Several dwarfs taken, one an albino, female, one-third the ordinary size.
Colias philodice anthyale. Several taken.
Colias interior. One specimen taken June, 1890.
Euchloe genutia. Taken by L. Ullrich (ex verbis). Specimens no longer extant.
Papilio ajax walshi. Common. Several dwarfs of walshi taken.
Papilio ajax abbottii. Not common. 6 spec. taken.
Papilio ajax telamonides. Common.
Papilio ajax marcellus. Common.
Papilio philenor. Fairly common.
Papilio asterias. Very common. One dwarf taken.
Papilio troilus. Common. One dwarf taken.
Papilio turnus. Fairly common. On Aug. 27, 1907, I caught a female, which is intermediate between the black and yellow forms.
Papilio turnus glaucus. Fairly common.
Papilio cresphontes. Very common. Frequents the blossoms of ironweed.
Epargyreus tityrus. Common.
Achellarus lycidas. Not common. Four taken.
Tharybes bathyllus. Common.
Tharybes pylades. Rare in woods. April.
Hesperia tessellaris. Common. July till Oct.
Thanaos brizo. Very rare. Early spring.
Thanaos juvenalis. Not quite as rare as preceding.
Thanaos persius. Rare.
Thanaos martialis. Rare.
Pholisora catullus. Exceedingly common. Dwarf taken June 22, 1882.
Ancyloxypha numitor. Common.
Erynnis sassacus. Rare. Taken by L. Ullrich.
Erynnis comma. Rare. Taken Oct., 1891.
Thymelicus mystic. Common.
Thymelicus aetna. Very common.
Polites peckius. Common.
Hylephila phylaeus. Rare. Taken Sept. 28, 1891.
Limochores taumas. Common.
Limochores pontiac. One spec. taken by L. Ullrich.
Limochores bimacula. One spec. taken June, 1891.
Limochores dion. Several taken by L. Ullrich, July 6, 1908. I took one in Shelby Co., O.

Euphyes verna. Very common.
Euphyes metacomet. Very common.
Atrytone zabulon. Very common.
Atrytone zabulon pocahontas. Not common.

Several other Hesperidae are in the collection which were beyond all doubt taken at Tiffin, but owing to a lack of positive data I omit them.

Heterocera (Moths).

Haemorrhagia thysbe. Fairly common.
Haemorrhagia thysbe cimbiciformis. Fairly common.
Haemorrhagia tenuis. Rare.
Haemorrhagia diffinis. Not common. July 18, 1905.
Haemorrhagia axillaris. Common. On July 5, 1905, I found a regular colony of larvae on weeds.
Amphion nessus. Not common.
Sphecodina abbottii. Fairly. common
Deidamia inscriptum. Rather rare. Taken by Ullrich.
Deilephila gallii. Not common. Taken by L. Ullrich.
Deilephila lineata. Fairly common.
Xylophanes tersa. Rare. Taken by L. Ullrich only.
Pholus fasciatus. Rare. Taken by L. Ullrich only.
Pholus pandorus. Common.
Pholus achemon. Fairly common.
Darapsa pholus. Fairly common. June, 1890.
Darapsa myron. Fairly common.
Erinnyis ello. Rare. Taken Aug. 20, 1891.
Erinnyis obscura. Rare. Taken Sept. 24, 1891.
Protoparce sexta. Common.
Protoparce quinquemaculata. Common.
Herse cingulata. Not common.
Chloeno gramma jasminearum. Rare.
Dolba hylaeus. Common.
Ceratomia amyntor. Not common.
Ceratomia undulosa. Not common.
Ceratomia catalpae. Rare. Taken by Murphy only.
Atreides plebeia. Fairly common.
Hyloicus kalmiae. Fairly common.
Hyloicus drupiferarum. Fairly common.
Hyloicus gordius. Fairly common.
Hyloicus eremitus. Not common.
Hyloicus chersis. Very common.
Pachysphinx modesta. Not common, in early spring.
Sphinx cerisyi. Not common.
Sphinx jamaicensis geminatus. Fairly common.
Calasymbolus excaecatus. Rare. Taken by L. Ullrich.
Calasymbolus myops. Rare. Taken by L. Ullrich.
Cressonia juglandis. Fairly common.
Sarnia cecropia. Very common.
Callosamia promethea. Not common.
Callosamia angulifera. Rare. Taken by L. Ullrich only.
Actias luna. Fairly common. A dwarf in the collection one-third normal size.
Telea polyphemus. Common. One dwarf.
Hyperchiria io. Common.
Basilona imperialis. Fairly common.
Citheronia regalis. Rare now, formerly common.
Adelocephala bicolor. Not common.
Syssphinx bisecta. Not common. Three spec. taken.

Anisota stigma.
Anisota senatoria.
Anisota virginiensis.
Anisota rubicunda.
These four species are now rare, while common in former years.
Hemileuca maia. This species never common, has of late become extinct. One specimen in the collection. The same conditions are true in this county (Auglaize) as Mr. Wm. Kayser, a Wapakoneta druggist and ardent lepidopterist has told me.
Scepsis fulvicollis. Rather common.
Lycomarpha pholus. Rather common.
Ctenucha virginica. Not common.
Hypoprepia miniata. Rare.
Hypoprepia fucosa. Common at light.
Holomellina opella. One spec. taken June, 1889.
Holomellina immaculata. Not common.
Holomellina aurantiaca ferruginosa. One spec. taken.
Utetheisa bella. Common.
Haploa clymene. Rare. Taken by L. Ullrich only.
Haploa lecontei dyari. Rare taken by L. Ullrich only.
Haploa lecontei militaris. Rare. Taken by myself only. June, 1907.
Estigmene acraea. Common.
Estigmene congrua. Rare. Taken by L. Ullrich only.
Hyphantria cunea. Common.
Hyphantria textor. Common.
Diacrisia virginica. Common.
Diacrisia virginica fumosa. Rare. Taken by Ullrich and myself.
Diacrisia latipennis. Rare. Taken June 27, 1882, June, 1890, and in Shelby Co., O., by myself on June 22, 1909.
Diacrisia vagans. Not common. Taken by H. F. Murphy only.
Isia isabella. Exceedingly common.
Apantesis virgo. Not common.
Apantesis virguncula. Not common.
Apantesis oithona rectilinea. Uncommon.
Apantesis arge. Rare. Taken Sept. 28, 1890.
Apantesis nais vittata. Common.
Apantesis nais phalerata. Common.
Ecpantherid scribonia. Rare. Two taken June 28, 1882.
Parteuchaetias tenera. Common.
Euchaetias egle. Common.
Halisidota tessellata. Not common.
Halisidota caryae. Common, About 40 taken on May 2, 1882.
Alypia octomaculata. Rather common.
Apatela interrupta. Not common.
Apatela hasta. Not common.
Apatela oblinita. Common.
Apatela americana. Not common.
Apatela lepusculina. Rare.
Apatela lobeliae. Not common.
Apatela albarufa. Not common.
Apatela brumosa. Rare.
Apatela furcifera. Rare. Taken by myself only.
Apatela xyliniformis. Rare. Taken by myself only.
Arsilonche albovenosa. Not uncommon.
Harrisimena trisignata. Rare. Taken by Ullrich only.
Moma fallax. Rare. Taken by Ullrich only.
Crambodes talidiformis. Rare. Taken by myself only.
Perigea xanthoides. Not common.

Perigea vecors. Not common.
Hadena miseloides. Rare. Taken Aug., 1890.
Hadena devastatrix. Common.
Hadena arctica. Common.
Hadena verbascoides. Common. June, 1890; July, 1905.
Hadena loculata. Rare. One spec. taken.
Hadena lignicolor. Rare. Two spec. taken.
Hadena mactata. Rare. One spec. taken.
Hadena modica. Fairly common.
Hadena dubitans. Fairly common.
Hadena sputatrix. Common.
Hyppa xylinoides. Common.
Euplexia lucipara. Not common.
Actinotia ramosula. Not common.
Dypterygia scabriuscula. Common.
Pyrophila pyramidoides. Common.
Prodenia commelinae. Not common. Sept., 1891.
Prodenia eudiopta. Common.
Prodenia eudiopta ornithogalli. Common.
Laphygma frugiperda. Common.
Homohadena badistriga. Not common.
Agrotis badinodis. Rare.
Agrotis ypsilon. Not common.
Peridroma saucia. Common. Swarms of this species with Heliophila unipuncta, were on the cherry trees in June, 1907, greedily devoured by the English Sparrows and Cedar Waxwings.
Noctua bicarnea. Common.
Noctua c-nigrum. Common.
Noctua clandestina. Common.
Noctua haruspica. Not common.
Feltia subgothica. Common.
Feltia herilis. Common.
Mamestra meditata. Not common.
Mamestra trifolii. Rare.
Mamestra adjuncta. Rare.
Mamestra renigera. Common.
Mamestra olivacea. Not common.
Mamestra lorea. Not common.
Heliophila unipuncta. Common.
Heliophila multilinea. Common.
Heliophila pseudargyria. Not common.
Xylina antennata. Not common. March 8, 1886.
Xylina laticinerea. Common. March and April, 1889.
Xylina signosa. Common.
Xylina oriunda. Very common. April 28, 1882.
Xylina unimoda. Rare. One specimen taken.
Cucullia asteroides. Common.
Gortyna velata. Not common. One spec. taken by myself.
Papaipema cerrusata. Not common.
Papaipema nitela. Not common.
Papaipema nitela nebris. Not common.
Papaipema furcata. Rare. One spec. taken in my house, Sept. 23, 1907.
Pyrrhia umbra. Not common.
Trigonophara periculosa. Common . Aug., 1891.
Eucirroedia pampina. Not common in fall.
Scoliopteryx libatrix. Common.
Orthosia bicolorago. Common.
Orthosia helva. Common.

Scopelosoma indirecta. Rare. Two spec. taken.
Scopelosoma sidus. Rare. March 25, 1889.
Scopelosoma morrisoni. Common. Twelve spec. March 15, 1889.
Heliothis armiger. One spec. taken by myself.
Rhodophora gaurae. Rare. Taken by L. Ullrich.
Rhodophora florida. Rare. Taken by H. Murphy, 1907.
Schinia lynx. Rare. Taken by H. Murphy, 1907.
Schinia marginata. Common.
Euthisanotia unio. Common.
Euthisanotia grata. Not common.
Plagiomimicus pityochromus. Rare. Taken by myself only.
Plusiodonta compressipalpis. Rare. Taken by myself only.
Autographa bimaculata. Not common.
Autographa biloba. Not common.
Autographa precationis. Common.
Autographa falcifera. Common.
Ogdoconta cinereola. Not common.
Alabama argillacea. Common.
Eustrotia musoscula. Not common. June 22, 1882.
Eustrotia apicosa. Common.
Eustrotia carneola. Very common.
Galgula hepara. Common.
Galgula hepara partita. Common.
Chamyris cerintha. Common.
Tarache terminimacula. Rare. June 3, 1890.
Tarache aprica. One spec. taken by H. Murphy.
Tarache erastrioides. Very common.
Tarache candefacta. Common.
Phalaenostoides larentioides. Common.
Hyamia sexpunctata. Common. June 4, 1882.
Hyamia perditalis. Not common.
Homopyralis discalis. Not common. June 14, 1882.
Homopyralis contracta. Not common.
Drasteria erechthea. Not common. May 9, 1882.
Drasteria crassiuscula. Very common.
Euclidia cuspidae. Rare. Two specimens taken.
Syneda graphica. Rare. Two specimens taken, 1882.
Catocala epione. Rare. Three specimens taken.
Catocala lacrymosa. Rare. One specimen taken.
Catocala vidua. Fairly common.
Catocala retecta. Fairly common.
Catocala robinsonii. Fairly common.
Catocala judith. Fairly common. July, 1891.
Catocala obscura. Not rare.
Catocala insolabilis. Not rare.
Catocala angusi. Not rare.
Catocala flebilis. Rare. Three spec. taken.
Catocala relicta. Very rare. One spec. July, 1892.
Catocala cara. Common.
Catocala amatrix. Common.
Catocala amatrix nurus. Common. Aug. 1890.
Catocala marmorata. Rather rare. Three specimens.
Catocala concumbens. Common.
Catocala unijuga. Common.
Briseis is in the coll. from Columbus, but not Tiffin.
Catocala parta. Common.
Catocala ultronia. Common.
Catocala ultronia celia. Common.

Catocala ultronia mopsa. Rare.
Catocala ilia. Rare. Three specimens.
Catocala nebulosa. Not common. Two specimens.
Catocala piatrix. More common than preceding.
Catocala innubens. Common.
Catocala innubens hinda. Rare.
Catocala innubens scintillans. Fairly common.
Catocala neogama. Not common. Two specimens.
Catocala cerogama. Fairly common.
Catocala subnata. Rare. Two specimens.
Catocala palaeogama. Fairly common.
Catocala palaeogama phalanga. Rare. Two specimens.
Catocala serena. Very common.
Catocala antinympha. Rare. Two specimens.
Catocala habilis. Very common.
Catocala habilis basalis. Not common.
Catocala polygama. Not common.
Catocala polygama crataegi. Not common. Four spec. taken July 19, 1882.
Catocala pretiosa. Not common.
Catocala amasia. Rare. One spec. taken.
Catocala grynea. Very common.
Catocala minuta. Rare. Four taken.
Catocala amica. Very common.
Catocala amica lineella. Fairly common.
Catocala pura. The moth taken in Aug., 1905, agrees with no other specimen, but comes fairly close to pura on the one side, and hermia on the other.
Allotrea elonympha. Not common. July and Aug., 1890.
Euparthenos nubilis. Rare. Three taken Aug., 1890.
Hypocala andremona. Two specimens taken Sept. 22, 1891, by L. Ullrich.
Phoberia atomeris. Not common.
Panapoda rufimargo carneicosta. Rare.
Panapoda rufimargo roseicosta. Rare. June 11, 1882.
Parallelia bistriaris. Common.
Celiptera frustulum. Rare. One specimen.
Strenoloma lunilinea. Rare. Taken by Ullrich, seen by myself July, 1907.
Zale horrida. Not common. July, 1907.
Phaeocyma lunata. Common. In this species and the related ones I follow Prof. John B. Smith—"A Revision of some species of Noctuidae, heretofore referred to the Genus Homoptera."
Phaeocyma undularis. Fairly common.
Phaeocyma lunifera. Fairly common.
Phaeocyma lineosa. Rare. Two specimens taken.
Thysania zenobia. A specimen of this splendid southern moth was taken September 3, 1890. I donated the specimen to the Ohio State University.
Epixensis lubricalis. Not common.
Epixensis scobialis. Rare.
Epixensis americalis. Not rare.
Epixensis aemula. Not common.
Zanglonatha laevigata. Not common.
Philometra eumelusalis. Common.
Chytolita morbidalis. Not common.
Renia discoloralis. Not common.
Heterogramma pyramusalis. Fairly common.
Palthis angulalis. Fairly common.
Bomolocha manalis. Fairly common.
Bomolocha baltimoralis. Fairly common.
Bomolocha abalinealis. Fairly common.
Bomolocha deceptalis. Fairly rare.

Plathypena scabra. Common.
Hypena humuli. Common.
Hormisa bivittata. Rare.
Pseudothyatira cymatophoroides. Not common.
Euthyatira pudens. Rare. One specimen, date not given.
Apatelodes torrefacta. Rare. Taken June, 1891.
Melalopha inclusa. Not common. April 22, 1882.
Melalopha albosigma. Not common. June 4, 1890.
Datana ministra. Common.
Datana angusii. Rather rare.
Datana major. Not rare.
Datana perspicua. Rare.
Datana integerrima. Not common. July 21, 1882.
Datana contracta. Not common. 1882.
Hyperaeschra stragula. Rare. June, 1890.
Nadata gibbosa. Not common. April 18, 1882.
Nerice bidentata. Not common.
Symmerista albifrons. Rare. One spec., 1907, taken by Murphy.
Heterocampa biundata. Not common.
Heterocampa bilineata. Not common.
Heterocampa umbrata. Rare.
Ianassa lignicolor. Rare. One spec., 1907, taken by Murphy.
Schizura ipomoeae. Rare. One specimen taken, no date.
Schizura unicornis. Rare. Two specimens taken, June 8, 1882.
Schizura leptinoides. Rare. One specimen taken.
Harpyia borealis. Common. June 12, 1882.
Harpyia cinerea. Common. June 12, 1882.
Fentonia marthesia. Rare. One specimen taken.
Hemerocampa leucostigma. Not common. July 12, 1882.
Tolype velleda. Rare. Four specimens taken—two by Ullrich, one by Murphy, one by myself.
Malacosoma americana. Not common. June 28, 1882.
Heteropacha rileyana. Very rare. One specimen taken.
Epicnaptera americana. Uncommon.
Oreta rosea. Uncommon. Aug., 1890. One specimen.
Dyspteris abortivaria. Common.
Eudule mendica. Common in woods.
Heterophleps triguttata. Common in woods.
Eucymatoge intestinata. Common.
Venusia comptaria. Not common.
Euchoeca albovittata. Rather rare.
Hydria undulata. Rather rare.
Eustroma diversilineata. Common.
Perenoptilota fluviata. Common.
Mesoleuca lacustrata. Not common.
Haematopis grataria. Very common.
Erastria amaturaria. Not common.
Synelys alabastaria. Fairly common.
Leptomeris quinquelinaria. Fairly common.
Eois ossularia. Fairly common.
Eois inductata. Fairly common.
Eucrostis incertata. Not common.
Synchlora aerata. Fairly common.
Eufidonia notataria. Not common.
Physostegania pustularia. Common.
Mellila inextricata. Common.
Philobia enotata. Not common.
Cleara pampinaria. Not common.

Erannis tiliaria. Fairly common.
Cingilia catenaria. Rare.
Therina fiscellaria. Rare.
Eugonobapta nivosaria. Common in woods.
Ennomos subsignarius. Rather rare.
Ennomos magnarius. Common. Sept. and Oct.
Xanthotype crocataria. Common.
Xanthotype crocataria caelaria. Common.
Hyperitis amicaria. Common.
Gonodontis hypochraria. Common.
Priocycla armataria. Not common.
Azelina ancetaria. Not common.
Caberodes confusaria. Fairly common.
Caberodes confusaria metrocamparia. Common.
Tetracis crocallata. Common.
Sabulodes sulphurata. Rare. Taken 1907 by myself.
Sabulodes lorata. Not common.
Sabulodes transversata. Common.
Abbottana clemataria. Not common.
Abbottana clemataria translucens. Not common.
Calledapteryx dryopterata. Not common.
Thyridopteryx ephemeraeformis. Very rare.
Cicinnus melsheimerii. Rare. Two sepecimens, June, 1890.
Sibine stimulea. Rare.
Euclea delphini. Not common. July 12, 1882.
Phobetron pithecium. Rare.
Packardia geminata. Rare.
Heterogenea shurtleffii. Rare. One spec. taken, no longer extant.
Lagoa crispata. Not common.
Prionaxystus robiniae. Not uncommon.
Cossus centerensis. Taken by Ullrich. Specimen gone.
Podosesia syringae. Common.
Memythrus asilipennis. Rare. One specimen taken by L. Ullrich.
Sanninoidea exitiosa. Common.
Sesia tipuliformis. Four specimens taken by L. Ullrich.
Sesia acerni. Taken June 12, 1882.
Sesia pyri. Two specimens taken by L. Ullrich.
Sesia bassiformis. Three specimens taken by L. Ullrich.
Sesia pyralidiformis. Four specimens taken by L. Ullrich.

LEAF MARKINGS OF CERTAIN OHIO PLANTS.*

JOHN H. SCHAFFNER.

Among the most familiar objects of our fields and gardens are such plants as the red and white clover with definite light-colored markings on the leaflets. Another equally prominent plant in gardens is the ribbon-grass (Phalaris arundinacea picta), whose leaves show variegated longitudinal bands of white and green color.

Sometime ago the writer began to collect data on the native and introduced plants of Ohio which show any definite type of markings. The problem is rather difficult since the markings usually disappear when plants are dried. It becomes necessary, therefore, to become acquainted with the plants in the living condition. During the past year a considerable number of species showing markings of various kinds have been observed, and the list could without doubt be considerably extended.

It has usually been customary to ascribe some purposeful effect or utility to the markings on the animal body and to the fantastic patterns shown by many flowers. It is open to question, however, whether such an assumption should be generally applied. The markings on the leaves of plants are favorable objects in this connection and may throw considerable light on the subject.

In many species, certain individuals have the markings while others lack them. There are probably elementary species present which might be segregated. These forms should make interesting material for the study of mutations and inheritance. In some species the markings are only on the younger leaves, in others only in connection with the inflorescence and thus on the latest leaves to be developed.

The markings of the leaves studied may be grouped under three general heads as follows:

1. Markings due to abnormal or diseased conditions, or the so-called variegations.
2. Markings more or less accidental, depending on some internal structure and evidently having no relation with the development of a definite pattern.
3. Markings which are of more or less definite patterns not dependent on fundimental structures.

Under the first group mentioned above would fall such forms as Phalaris arundinacea picta, already mentioned and the numerous vairegated species commonly cultivated in greenhouses. The white bands or spots being due to a lack of chlorophyll in the parts. White stripes are frequently to be observed in young plants of corn, Zea mays, and occasionally the entire plant is white. These latter individuals usually do not survive long.

* Read at the meeting of the Ohio Acad. of Sci., Nov. 25, 1910.

The leaf-markings distinguished in the second group, namely, those depending on some structural peculiarty, are perfectly normal and may also be present generally or only on some individuals. The leaves may be covered with minute spots or dots caused by internal glands as in Hypericum maculatum where the dots are often black or dark blue, and as in Boebera papposa where they are oval in shape and of an orange color. In most species the dots or punctations are, however, too small to be seen by the unaided human eye, although conspicuous under a lens. Nelumbo lutea has a peculiar light-colored marking in the center of the large peltate leaf that has some resemblance in outline to certain species of beetles. The marking is purely structural and accidental, yet were green beetles in the habit of frequenting these leaves it might be cited as a remarkable case of mimicry.

The most common markings of this general type are those which follow the venation of the leaf-blade, often forming reticulations. Examples of species with red veins and reticulations are Hieracium venosum, Viola hirsutula, and Rumex obtusifolius. Argemone mexicana is perhaps the most striking example among those with white markings over the veins. The leaves of Mitchella repens show a pale-green narrow stripe over the midrib and Euphorbia nutans has part of the midrib marked by a white streak. The leaves of Peramium pubescens has a beautiful white reticulation over a dark-green background, with occasional white blotches.

The most interesting examples of leaf workings, however, come in the third group designated above. In the first place, the leaf blade may be some permanent, uniform color other than green. Oxalis rufa is a plant of this character. The color in such cases may have a physiological use in protecting the chlorophyll.

Numerous leaves have a silvery mottled or blotched appearance of more or less definite pattern. Among such are the following: Hydrophyllum appendiculatum, H. macrophyllum, H. virginicum, Hepatica hepatica, H. acuta, and Chimaphila maculata. Smilax glauca has the same type of markings at least in the young condition. Cucurbita pepo and C. maxima have prominent angular silvery patches, covering the leaf blade, in the angles of the veins. In the Hydrophyllums, the main variegation usually extends on each side of the midrib and occurs in smaller spots beyond, especially at the notches of the serrations.

Other plants having mottled or blotched leaves are Erythronium americanum, E. albidum, Lamium album, L. maculatum, Trillium sessile and T. recurvatum. In Trillium sessile the markings are usually very prominent, while in T. recurvatum they are not always visible. Arisaema triphyllum has beautiful reddish-brown and whitish spots on the sheathing bracts, petioles and peduncles but the leave blades are green.

The plants of the greatest interest are those with definite, often symmetrical patterns, which can have no relation to the general structure. For here we come face to face with the difficult problem of symmetrical coloration in general. Oxalis grandis has beautiful leaves with an ornamental brown margin. Euphorbia marginata has milk-white bands on the leaves surrounding the flower clusters. In the second example the claim might be made that the striking color patterns around the flowers were developed through insect selection. In the first case such an explanation would, of course, be out of the question. In Euphorbia maculata and E. nutans, the leaf blades have an irregular oval dark-red spot in the center, the latter species having in addition the white streak over part of the midrib, as mentioned above. Some individuals of Euphorbia nutans do not show the red spot.

Trifolium pratense and T. repens have light-colored ornamental markings on the three leaflets which together make a very striking and symmetrical design. Oxalis violacea often has a similar marking on the leaflets but it is red or purple in color.

Polygonum lapathifolium has a faint, irregular, elongated spot in the middle of the leaf on the upper side while P. virginianum has somewhat similar dull, reddish spots in the center of the leaves. In Polygonum pennsylvanicum, the leaf has a dark-colored sagitate spot in the center, the point extending in the direction of the tip of the blade. In some individuals the leaves show no markings. The leaves of Polygonum persicaria have a very definite dark reddish or brownish oval spot in the center. Occasionally one finds individuals having in addition a distinct band of the same color running along each margin. The central spot may also be slightly sagitate in outline. Such leaves are among the most fantastic in design to be observed and well deserve careful study.

It seems out of the question to attempt to explain the origin and presence of ornamental and symmetrical patterns on leaves from the standpoint of utility. We are led to the position that there are both useful and useless structures developed in plants, the useless markings under consideration not representing degenerations. By no exercise of the imagination could one see in these designs and patterns any use to the possessor. They have probably come about through mutative changes and represent elementary species. The beautiful colors and patterns are of as much use to the plant as the beautiful colors and forms are to a rock crystal or to a snowflake.

Because of the numerous purposeful and useful structures and functions exhibited by organisms, biology was misled far into the camp of the utilitarians. But the philosophy of life has many sides and the recent discoveries in Mendelian inheritance, mutation and orthogenesis have revealed some of its complexity.

NEW AND RARE OHIO PLANTS ADDED TO THE STATE HERBARIUM IN 1910.*

JOHN H. SCHAFFNER.

In the catalog of Ohio plants now almost ready for publication, there will be a considerable number of new names and transferred species because of critical studies on different groups. These changes are not included in this list. The species given below represent important additions made in the usual way during the past year. Some species sent in have not yet been carefully studied and so are deferred for a future report.

Adiantum pedatum laciniatum Hopkins. Wayne County, L. S. Hopkins.

Filix fragilis cristata (Hopkins). Woodworth's Glen, Portage County, L. S. Hopkins.

Carex decomposita Muhl. Cranberry Island, Buckeye Lake, Licking County, Freda Detmers.

Festuca ovina L. Sheep Fescue-grass. Columbus, Franklin County, J. C. Hambleton.

Heleochloa schoenoides (L.) Host. Cat-tail Grass. Yellow Springs, Greene County, L. S. Hopkins.

Clintonia borealis (Ait.) Raf. Yellow Clintonia. Pymatuning Swamp, Ashtabula County, C. A. Davis, A. Dachnowski, and Freda Detmers.

Trillium undulatum Willd. Painted Trillium. Pymatuning Swamp, Ashtabula County, C. A. Davis, A. Dachnowski, and Freda Detmers.

Polygonum careyi Olney. Carey's Knotweed. Union Corners, Erie County, E. L. Moseley.

Kochia scoparia (L.) Roth. Mock Cypress. Columbus, Franklin County, John H. Schaffner.

Dalibarda repens L. Dalibarda. Pymatuning Swamp, Ashtabula County, C. A. Davis, A. Dachnowski, and Freda Detmers.

Azalea viscosa L. Swamp Azalea. Pymatuning Swamp, Ashtabula County, C. A. Davis, A. Dachnowski, and Freda Detmers.

Galium mollugo L. White Bedstraw. Bloomingburg, Fayette County, H. F. Hughes.

Eupatorium serotinum Mx. Late-flowering Thoroughwort. College Hill, Hamilton County, Lucy Braun.

Eupatorium rotundifolium L. Roundleaf Thoroughwort. Hocking County, R. F. Griggs.

Eupatorium aromaticum L. Smaller White Snake-root. Hocking County, R. F. Griggs.

Gifola germanica (L.) Dum. Herba Impia. Washington, Guernsey County, Emma E. Laughlin.

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* Presented at the meeting of the Ohio Acad. of Science, Akron, Nov. 25

NOTES ON OHIO AGARICS II.

WILMER G. STOVER.

During the fall of 1910 two Agarics were collected by the writer which seem worthy of especial notice.

Pleurotus corticatus Fr. Pileus 5-20 cm., fleshy, whitish at margin to grayish-brown at disk, convex, dry, marginate behind; at first floccose, finally floccose-scaly; margin even, flesh thick, white.

Lamellae white or lutescent, subdistant, broad (6-10 mm.), decurrent, often forked, anastomosing behind. Spores white, oblong, 4-5 x 9-11 mic.

Stipe 3-11 x 1-4 cm., white, sometimes yellowish at the base, eccentric, fleshy, firm, solid, tapering downward; sometimes rather short but usually long and rooting; pruinate above, floccose-pulverulent below.

Veil white, lacerate, rather thin; sometimes forming a slight annulus but mostly appendiculate to margin of pileus.

Growing from large decayed spot in living elm; somewhat gregarious. Over twenty pilei were found at the time. Columbus, O., Oct. 26, 1910.

Morgan* reported this species from the Miami Valley over twenty-five years ago, and F. M. O'Bryne collected immature specimens of the same species at Oxford, O., Oct. 26, 1909. In both these collections the pileus was white or whitish. My specimens differ somewhat from the Friesian description, but the differences are not of specific importance. In some respects they agree with P. dryinus (Pers.) Fr., but the differences are greater than the resemblance.

Collybia tuberosa Bull. Pileus 2-5 mm., convex, subumbonate, glabrous or nearly so, even, white or with brownish tinge. Lamellae, white, thin; distant and rather broad for size of pileus. Spores white, elliptical. Stipe, .5 x 5-20 mm., arising from rounded yellowish or brownish tubercle; flexuous, white to rufescent, fragile, glabrous at top, white-tomentose toward base.

The plants were growing upon decaying fungi and other vegetable matter, and were rather smaller than the sizes given by Peck. The lamellae are usually described as "close," but I should call them rather distant for the size of the pileus. The species may be readily recognized by the prominent sclerotioid tuber at the base of the stipe. Collected at Sugar Grove, O., Nov. 5, 1910.

The plants reported from the Miami Valley by Morgan (l. c., p. 73) as C. cirrhata Schum., probably belonged to this species since C. cirrhata does not have sclerotia. In Morgan's herbarium, now at Iowa City, Iowa, there are specimens labeled Marasmius sclerotipes Bres., which probably are also C. tuberosa.

Bot. Dept., Ohio State Univ.

* Morgan, A. P., Mycologic Flora of the Miami Valley, Jour. Cin. Soc. Nat. Hist. 6 : 79, April, 1883.

MEETING OF THE BIOLOGICAL CLUB.

Orton Hall, June 16, 1910.

The last meeting of the Club for the school year was called to order by the President, Mr. Morse, and the minutes of the previous meeting were read and approved.

The nominating committee reported the following nominations for the staff of The Ohio Naturalist:

Editor-in-Chief—John H. Schaffner.

Business Manager—James S. Hine.

Asst. Business Manager—G. D. Hubbard.

Associate Editors—F. L. Landacre, Zoology; Freda Detmars, Botany; W. C. Morse, Geology; W. C. Mills, Archaeology; J. C. Hambleton, Ornithology; G. D. Hubbard, Geography.

Advisory Board—Herbert Osborn, Charles S. Prosser, John H. Schaffner.

The report was accepted and the staff elected.

The speaker of the evening was Prof. T. H. Haines. His subject was "Experimentation on Mental Processes in Animals." Prof. Haines gave a brief review of the work which has been done along this line, told of a number of very interesting experiments, and presented some of the theories which have been worked out.

M. G. Dickey, *Secretary.*

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REMARKS ON THE GENUS SCAPHOIDEUS WITH A REVISED KEY AND DESCRIPTIONS OF NEW AMERICAN SPECIES.

HERBERT OSBORN.

Since the publication of my paper on this genus in 1900* there have been a number of other species described, and I have secured records of distribution which considerably increase the range for a number of the older species, and moreover have recently obtained material which adds to these records, so that it appears to be an appropriate time to review the work presented in that paper.

At the time the paper was written the genus seemed to be quite strictly American and with the exception of a species described from the West Indies, St. Vincent Id., by Professor Uhler, the range of the genus being distinctly Nearctic. A species described from Japan, and more recently the description of two other species from the Palearctic region shows that the genus has a wider range and would indicate for it a greater antiquity. Of the species which have been described as American since my previous paper on the genus, three are distinctly western, one distinctly eastern, and one southern or southeastern in range. Four species apparently new are described in the present paper.

But little has been added with reference to the life histories of the species, and in general the habits of the species are such that observations upon the life histories seem not to be very readily made. Considering the accessibility of my earlier paper it is deemed unnecessary to repeat descriptions or bibliography.

* The Genus Scaphoideus, Jour. Cinc. Soc. Nat. Hist., Vol. XIX, pp. 187–209. (June, 1900.)

No type species for the genus was indicated by Uhler and none so far as I know has been named since. I would therefore name immistus Say., the first species listed by Uhler in his paper describing the genus, and a distinctly representative species, as the type.

With some slight emendations the key presented in my former paper seems to possess the essential basis for the arrangement of the species, and in the revised key this arrangement has been followed in the main, simply making such additions and changes as permit of the inclusion of the other American species.

Key to the American Species.

Lorae remote from the margin of the cheeks; common elytral picture cruciate; claval vein straight, meeting suture at acute angle........1
Lorae contiguous to or merging with border of cheeks elytral picture not cruciate, outer claval vein curved or hooked at the distal end....2
1. Face yellow without cross bands .... **sanctus** Say
   Face with two dark cross bands beside frontal arcs................3
3. Vertex short, very obtuse, size small, 4 mm........ **fasciatus** Osb.
   Vertex longer, rounded or sub-angular, size larger. 4
4. Fore and middle femora yellow annulated with black...**neglectus** nsp
   Fore and middle femora black, base and apex yellow.. **cruciatus** nsp
2. Post nodal cell scarcely widened distally..... 5
   Post nodal cell much widened distally....... 6
5. Post nodal cell without cross veinlets........ . . . 7
   Post nodal cell with cross veinlets........ . .. 8
7. Nodal vein arising from discal cell..... . . . **auronitens** Prov.
   Nodal vein arising from anteapical cell... 9
9. Vertex flat with transverse impressed line.... 10
   Vertex convex, no impressed line, edges rounded.. . . 11
10. Nodal vein from front of cell... **jucundus** Uhl.
    Nodal vein from middle of cell... **fumidus** Ball
11. Vertex wider than long, obtuse or rounded... 12
    Vertex as long or longer than wide, acute, **scalaris** V.D.–**stigmosus** Uhl.?
12. Vertex subacute.. 14
    Vertex obtuse or rounded, small..... **mexicanus** Osb.
14. Nodal cell more than twice as long as wide. ...16
    Nodal cell but little longer than wide. . **unicolor** Osb.
16. Claval spots oval distinct. . . .. **albonotatus** V. D.
    Claval spots elongate faint .. ... **consors** Uhl.
8. With few cross nervures in costal cell... ...17
   With numerous cross nervures in costal cell... .18
17. Clavus reticulate. . . **irroratus** nsp.
    Clavus not reticulate.. **lobatus** V. D.
18. With brown saddle on elytra... .. **scrupulosus** Ball
19. Without brown saddle on elytra.... **blandus** Ball
6. Outer claval not strongly hooked at distal end, cross nervure to claval suture indistinct or wanting........... ... .20
   Outer claval strongly hooked at distal end, usually with distinct cross nervure from outer claval to claval suture................21
20. Outer claval sinuate approaching inner near its middle.............22
    Outer claval nearly straight and parallel to inner, curved at tip.....23
22. Light ochreous, ultimate ventral segment truncate or slightly notched ... . **ochraceous** Osb.
    Marked with fuscous, ultimate ventral segment produced, **productus** Osb

23. ♀ ultimate ventral segment carinate, toothed at middle, **carinatus** Osb.
♀ ultimate ventral segment not carinate, or toothed at middle.....24
24. Head and pronotum ivory white or yellowish......... **intricatus** Uhl.
Head and pronotum with darker areas luteous or fulvus..**luteolus** V. D.
6. No distinct cross veins between claval veins; colors gray or brown marked with fuscous.... 25
Usually a distinct cross vein between clavals.... .26
25. Face brown or light varied with darker markings..... **immistus** Say
Face black with white arcs..... ...**nigricans** nsp.
Face yellow... **opalescens** Osb.
26. Outer claval approximating claval suture posteriorly; face black **melanotus** Osb.
Outer claval remote from claval suture posteriorly.................27
27. Vertex obtusely angulate; apex of elytra fuscous or black, **obtusus** Osb.
Vertex more produced, subacute; elytra entirely gray..**cinerosus** Osb.

Scaphoideus sanctus Say.

Scaphoideus picturatus Osborn Proc. Ia. Acad. Sci. V, p. 243, (1898).

The original description for this species was based on specimens from Indiana, but no type specimens exist. The only species which has been secured from this region in recent years, agreeing with Say's description, is the one which I described under the name picturatus from material collected in Iowa and Kentucky.

Recent collections have shown this form to occur in Southern Ohio and at other points in the Ohio valley, but it has not been taken on the Atlantic slope nor in the Gulf States. Since the form hitherto known under the name sanctus, following Van Duzee's reference in 1894, has never been found in the Ohio valley nor outside of the Atlantic coast or Gulf States, there seems abundant reason to make the change suggested in my former paper and to recognize the Ohio valley form as sanctus. With this change the form occurring on the Gulf coast and which has the broad black band across the face remains undescribed. It resembles very closely the fasciatus described from Haiti, but as suggested by Van Duzee differs from that form in size and details of head, so that it seems best to recognize it as a distinct species. (See neglectus, poste.)

The sanctus of Say has a somewhat more pointed vertex, and the front is entirely without the black band which is so conspicuous in the other form. Say's statement "feet immaculate" applies better here than to the other form though there are black points on the tibia. The localities for this species will now stand as Indiana, (Say), Iowa (Osborn), Missouri, (Riley), Kentucky, (Garman), Illinois, Metropolis, "River," C. A. Hart, 3 females, 3 males, in Ill. State Lab. Natural History, and Ohio, (Osborn), the localities in the latter state being Marietta and Portsmouth. Practically all of these records are based upon single specimens, which indicates a distinct rarity for the species. The specimen I took at Marietta was found on willows or vegetation close to them, but

where there was too much mixture of various plants to warrant the fixing of the host plant. For the other records no definite food plant has been given, so that we cannot assume to name the host species.

This form agrees closely with the others of the fasciatus group in the cruciate marking upon the dorsum, making with these forms a distinct subdivision of the genus. They differ somewhat from the other members, but in view of the venation and the head characters it seems hardly desirable to separate them from the genus.

Scaphoideus fasciatus Osb.

Jour. Cinc. Soc. N. H., Vol. XIX, p. 190.

This species described in 1900 from Port au Prince Haiti, has been recognized by Van Duzee from Florida and is probably best retained as a distinct species, although it is certainly closely related to the succeeding species described to cover the southern form hitherto known as sanctus. In this species the head is rather short, the points at the tip of the vertex minute, the transverse band on the face double and continued laterally on the pleurae, and the length is about four millimeters.

There is a specimen in the National Museum bearing a Ms. (apparently unpublished) name from Granada which agrees closely with this species. Van Duzee records are for Crescent City and St. Petersburg, Fla.

Scaphoideus neglectus n. sp.

Scaphoideus sanctus, Van Duzee. Tr. Am. Ent. Soc. Vol. XII, p. 300.

Closely resembles fasciatus and cruciatus, but is larger and with the vertex more angular than the former, smaller, with different markings on vertex, face, femora, and genital plates than the latter. Length four to four and one-half millimeters.

Vertex rounded, bluntly angular, about one and one-half times as long at center as next to the eye; the front broad at base, narrowing very uniformly and rapidly to the clypeus; clypeus widening slightly to the apex; lorae moderate, rounded, not reaching the border of the cheeks, the border of the cheeks slightly sinuate; pronotum strongly arched in front, truncate, or very slightly emarginate on hind border; elytra with the venation as in related species, the reflexed costal veins distinctly and about equally oblique.

Color, whitish ivory tinged with gray and marked with black and brown; the vertex with transverse black bands just in front of the middle, a pair of minute, almost obsolete, black points near the apex, and four black points on the hind border; the front with two black arcs next the vertex and a black band from below the eyes across the front just beneath the antennae; the apical portion of lorae and clypeus and sub-margin of cheeks black or dark brown; the anterior femora black above, yellowish at base and apex and beneath, middle femora yellow with a black annulus at the tip; hind femora yellow, hind tibiae yellow with black points; tarsi yellow annulated with black; pronotum ivory white in front, gray brown behind, with

two or four black markings in a transverse line near the front. In the male the four oval black spots on the hinder half; scutullum with a black dot in the anterior angle; elytra similar to the related species with the basal part of corium ivory white; the oblique white mark on the apical portion of the clavus straight and scarcely inflated next the commissure; the ante-apical cells mostly brown with white dashes following the veins; apical cells, 1 partly white, the remainder black, 2 entirely black, 3 black apically whitish transparent for a large central spot, 4 semi-transparent in the central portion; beneath the venter white with black margins to the segments; base of pygofer black, and a black dash on the apical portion; ovipositor black, yellow at tip. In the male the valve is black and the plates with a sub-margin of blackish. There is also a central line of black spots on the venter.

Genitalia—Last ventral segment of the female short, nearly straight on hind border, pygofer rather long, equaling the ovipositor. The male valve small, distinctly rounded behind, the plates short, about one-half the length of the pygofer, broad, rounded on the border and at the tip minutely ciliate; pygofer rather long and densely ciliate.

Described from five specimens—one female, Plano, Texas, a male and female labeled "Texas," one male, Clearwater, Fla., and one male, Frontera Tobasco, Mex. This last the one which was formerly referred to fasciatus Osb. I have also seen specimens as stated under sanctus in my previous paper, from Fla. in Van Duzee Collection, from "Texas" collected by Aaron and one from Jacksonville, Florida, from Mr. Heideman. Mr. Van Duzee records a female from Clearwater, and a male from Ft. Myers.

Scaphoideus cruciatus n. sp.

Scaphoideus sanctus Say?? Osborn, 20th, Rep. State Entom., N. Y., 1904, p. 523 (1905).

Closely resembling fasciatus but larger, with the vertex more produced, and genital plates of the male more distinctly rounded and longer. Length ♂ 4.5 mm.

Vertex rounded, slightly angular in front, little more than half as long at middle as between the eyes; the front broad, narrowing sharply to the clypeus; lorae short, coming far short of the margin; prothorax strongly curved in front, truncate behind; scutellum broad, deeply indented at the middle; elytra extending beyond the abdomen. The reflexed veins two in number, the first one strongly oblique, the second slightly oblique enclosing a rather short stigma.

Color, yellowish ivory white marked with fuscous and black; the vertex yellowish with two transverse brown spots just in front of the middle; two minute black dots in a faint brown splash near the hind border; the front with two black arcs close to the vertex; a distinct bar from lower border of eyes crossing below the antennae, and a broader black bar across the clypeus and enclosing lower half of the lorae and apex of clypeus and continued for coxae and pleurae; the upper half of lora yellow margined with black; beak yellow. The fore and middle femora black with yellow at base and apex; tibiae yellow, tarsi yellow banded with black; elytra with the common cruciate brown mark bordered distinctly with dark brown or black; the oblique white mark of clavus inflated at commissure. Anteapical cells brown bordered with black their veins white. First and second apical cells mostly black, third mostly transparent, veins white, together forming a semi-transparent spot at the inner angle.

Genitalia: Male valve short, broadly rounded behind; plates broad, short, about half as long as pygofer, rounded on the outer border, slightly angular, almost acuminate at tip, distinctly ciliate as is also the pygofer.

One specimen, male of this form from Cold Spring Harbor, Long Island, from Mr. H. G. Barber. It has hitherto stood under the name Sanctus Say? from the reference in my catalogue of the Jassidae of N. Y., but as indicated under the preceding species, it cannot be the form described by Say.

It is quite close to neglectus from Florida and Texas but differs so distinctly in the width of bar on front, the absence of oval spots on the pronotum, color of femora, the elytral marking, and especially in shape, and marking of genital plates that it must be separated at least until intermediate forms are secured.

Scaphoideus auronitens. Prov.

This species has been found at a good many localities outside of the original habitat cited, and among these are Channel Lake, Ill., Cold Spring Harbor, L. I., Ohio Pyle, Pa., Crisp, Pa., Knoxville, Tenn., and Monterest, N. C. In these different localities the species retains very closely its characteristic features, having very little tendency to variation. The larval stages were recognized and described in my report on the Jassidae of New York State, 1904.

Scaphoideus jucundus Uhler.

In the various records for this species it has been limited mainly to northern localities, Canada, New York, Iowa, and south to Washington, D. C., but I have seen specimens from Tryon, N. C., which were taken by Mr. Fiske, and Mr. Van Duzee records it for Estero, Florida. It may therefore be regarded as covering the eastern United States.

Scaphoideus fumidus Ball.

Canadian Entomologist, Vol. XXXIII, p. 8.

"This species resembles blandus in form and size: color rich testaceous brown, the margins of vertex and pronotum and apex of elytra. Length five millimeters; width 1.5 mm." This species also was described from Colorado, and no other records are known to me.

Scaphoideus consors Uhler.

The additional material secured for this species seems to establish the point of its distinctness from scalaris, although it is possible to secure specimens that stand intermediately between the two species. This species is more distinctly eastern, the various records covering New York to Texas, and additional records show its occurrence at Ohio Pyle, Pa., and at Tryon, N. C., and Van Duzee records it for Crescent City, Fla. The form which was separated as variety unicolor in my previous paper seems to be sufficiently distinct to warrant its separation as a distinct species, no intermediate or connecting forms having been observed.

Scaphoideus unicolor Osb.

Scaphoideus consors var. *unicolor* Osborn, Jour. Cinc. Soc. N. H., Vol. XIX, p. 196 (1900).

This species, as indicated above, is now separated from consors, and the characters given in the description of it as a variety will stand as the specific characters. The essential features in its separation will be the structure of the genitalia, although the intensity of coloration appears to be a fairly constant character. The post nodal cell is short and bordered by heavy brown cross veins. No additional localities have been recorded, but I have specimens from Chester, Ga., Anacostia, D. C., Provincetown, Mass., Staten Id., N. Y., so that its distribution now includes the territory from Massachusetts to Georgia and Alabama.

Scaphoideus mexicanus Osb.

This species described from Orizaba, V. C., Mex., from specimens which I secured there in January, 1892, has not been noticed in any recent collections.

Scaphoideus scalaris Van Duzee.

The various records of this species include localities all the way from Ohio to California, and more recent records include New York. I have also a record for Ohio Pyle, Pa.

Scaphoideus albonotatus Van D.

Buffalo Soc. Nat. Hist., Vol. IX, p. 226 (1909).

This species described by Mr. Van Duzee from specimens collected at Estero, Fla., belongs to the **scalaris** group. It is closely allied to consors and unicolor, but larger and stouter than either and marked with three pairs of oval white spots along the commissure of the elytra. The length is 5½ millimeters. The distinct markings, especially the shape of the elytral spots, and length of post nodal cell, separate this certainly from unicolor. The species has not been taken outside of the type locality.

Scaphoideus stigmosus Uhler.

Proc. Zool. Soc., London, 1895, No. 6, p. 77.

This was described by Mr. Uhler in his report upon the Hemiptera Homoptera of the Island of St. Vincent. According to this description the species is related to scalaris. Uhler's description is in a somewhat inaccessible paper, and for the benefit of American students may be reproduced here, especially as I have not seen specimens of the species and cannot give a complete description:

"Pale fulvous; form similar to **S. scalaris,** Van Duz., but with a longer and wider head and antennae nearly as long as the wing-cover. Vertex a little longer than its width between the eyes, almost flat, very pale fulvous, with a series of brown dots around the anterior submargin and some less regular ones on the middle, occasionally with two or three ivory-white dots before the middle; front irregularly clouded with pale brown, bounded above by a slender dark brown line. Clypeus broad, bluntly rounded, marked with a brown subapical spot; the rostrum reaching to the middle coxae. Eyes with a dark brown band below. Antennae dark brown, paler at base. Pronotum triangularly sublunate, well advanced into the deeply sinuated vertex, the surface minutely scabrous, transversely wrinkled, polished, dotted with pale yellow anteriorly, and minutely speckled with the same color behind the middle; the posterior angles subacute, a little produced, the posterior margin slightly sinuated. Scutellum with a dark brown spot in the basal angles; the disk a little marbled with brown. Wing-covers marked with three brown spots on the inner margin of the clavus, each of which has an acute white spot at the tip; veins white interrupted with brown, margins pale; the costal margin has a series of broader white streaks adjoining it inwardly, four large apical cells pale at base, bounded by brown veins, the apex a little dusky; wings smoky, with dark brown veins. Beneath and legs pale yellow, the tibiae somewhat marked with brown; the tarsal joints, nails, and spots at origin of the tibial spines dark brown; the spines pale brown. Last ventral segment of the female deeply notched, the valves of ovipositor set with long, brown, stiff bristles; tergum blackish, with pale edges to the segments and a pale tip.

"Length to end of venter 3¼ mm., to tip of wing-covers 5 mm.; width of pronotum, 1 mm.

"Five specimens, all females, were secured on the island. One was taken at an altitude of 1500 feet above the sea, and two were collected at Kingstown."

Scaphoideus lobatus Van D.

This rather rare species described by Van Duzee from New York has been taken in Ohio at Milan, and I have seen specimens from Balsam, N. C., Madison, N. J., Cold Spring Harbor, L. I., and it has been reported in Iowa, so that it may be considered as occupying the northern part of the United States, extending south on the elevated Appalachian region. Nothing has been added concerning its life history

Scaphoideus blandus Ball.

Canadian Entomologist, Vol. XXXIII, p. 7.

This species described by Professor Ball in 1901 has the general appearance of jucundus, but is smaller and duller looking, the reddish tinge of that species being lacking. The costal margin of elytra with numerous regular cells. Length five millimeters; width 1.1 millimeters. This species was described from various localities in Colorado, and has not been recorded from any other region.

Scaphoideus scrupulosus Ball.

Canadian Entomologist, Vol. XXXIV, p. 14.

This species is somewhat out of place in the genus Scaphoideus, but can not readily be referred to any other genus. The head characters agree distinctly, but in the appearance of wings and other features it is more like that of Eutettix. In the description by Professor Ball he says it is similar to blandus and jucundus in form, the elytra more flaring, and with the general appearance of Eutettix, except for the sharply angled vertex, a brown band on the base of the elytra, another on tip, and a triangular saddle on the disc. Length five millimeters; width 1.25 millimeters. Professor Ball's specimens were from Los Angeles, Cal., and I have one specimen from Sonoma Co., California, so that the species appears to be limited to that region.

Scaphoideus irroratus n. sp.

Somewhat resembles scrupulosus, but more distinctly irrorate and with the female ventral segment without any median appendage. Length ♀ 5 mm.

Vertex distinctly angular, nearly twice as long at center as next the eyes; the front rather broad, narrowing but little to the clypeus; the clypeus narrowing at base, widening slightly to the tip; the lorae rather large, oval, approaching the border; cheek distinctly sinuate under the eye; pronotum short, distinctly arched in front, slightly emarginate behind; elytra with numerous veinlets.

Color, fulvus and brownish, distinctly irrorate with fuscus on the pronotum and elytra; vertex tawny with indefinite transverse brownish irrorations; face without spots but with front suffused with fulvus; pronotum and scutellum about equally marked with brownish irrorations; the elytra with the irroration following the transverse veinlets and brown spots massing so as to form a rather indefinite saddle in front of the middle, and a transverse broad band on the apical third, leaving a rather clear space crossing the apex of clavus and reaching the costa; the costal cell with about three transverse veinlets; the post nodal cell with about six transverse veinlets bordered with fuscus; beneath brownish, tibiae and tarsi spotted with black.

Genitalia, last ventral segment of the female longer than the preceding and very slightly produced at center; ovipositor reaching the tip of pygofer; pygofer with short cilia next the border.

Described from a single female specimen from the University of California campus, Berkeley, from the Department of Entomology of the University of California. This species, while somewhat resembling scrupulosus and differing from typical Scaphoideus, presents the head characters of the genus, although the antennae are shorter than is the general rule with the genus.

Scaphoideus intricatus Uhl.

Additional records for this species have been secured for Columbus, Ohio, taken on clover in September, 1909; at Akron on Cornus, September, 1909, and a record from Professor H. Garman for Lexington, Ky., September 20, 1909, on cultivated grape, also from Franconia, N. H., by Mrs. Slosson. The original description referred this species to Crataegus, but it has been taken on so many different plants and in some cases so remote from this tree that it is uncertain as to its normal food plant. So far as I know the larvae have not been seen, and consequently the food habit as determined by the larvae is uncertain. The species is now known to range from Kansas and Nebraska to New Hampshire and south to Virginia and Kentucky.

Scaphoideus ochraceus Osb.

Further records showing distribution of this species have been secured since the publication of my paper in 1900, for Durham, N. H., Buffalo, N. Y., 1907, and Ohio Pyle, Pa., Aug. 10, 1905. It must undoubtedly occur in Ohio, but so far has not appeared in collections.

Scaphoideus productus Osb.

This species has been recognized at various localities, especially to the south. I have records for Balsam, N. C., at altitudes of 4500 to 5000 feet, from the Department of Agriculture of North Carolina, and have also seen specimens collected at Tryon, N. C., by Mr. Fiske. Mr. Barbour has sent me a specimen from Cold Spring Harbor, L. I., so the species is pretty well distributed from Onaga, Kansas, Sioux City, Ia., east through Kentucky into North Carolina, and north to New York.

Scaphoideus carinatus Osb.

This species has been recorded from Cold Spring Harbor, L. I., (Barbour) and Black Mt. (Beutenmueller) Tryon, N. C. (at light) from Fiske, Little Mt., Ohio, in addition to the previous records. So far no specimens have been obtained from western localities, so that it appears to belong to the Atlantic region from New Hampshire to North Carolina, and west to eastern Ohio at least.

Scaphoideus nigricans n. sp.

Closely related to immistus, but much darker and with the female genital segment longer, and with a polished produced hinder border. Length 5.5 mm.

Vertex about twice as long at middle as next the eye, rounding to a distinct obtuse angle at the tip; front rather narrow, sloping uniformly to the clypeus which is distinctly widened apically; lorae large, touching the border of the cheek; pronotum distinctly emarginate behind; elytra trans-

lucent, the claval veins approaching each other near the center, but without any distinct cross vein; the reflexed venis three, first ante-apical not stylate.

Color, dark brown, mostly black beneath; vertex dark brown with light areas at the sides in the anterior half; face black with four white arcs on the upper half of the front; pronotum dark brown, two white spots on the anterior border; scutellum with four white points on the base, one at apex, and one each side midway from apex to base; elytral markings as in immistus, but darker; beneath black except median and lateral line on the venter, the basal part of the last ventral segment white, the lower part of femora and the tibiae whitish; tarsi annulated with white.

Genitalia. Last ventral segment of the female long, produced and slightly notched on the posterior border, distinctly polished; ovipositor and pygofer dark brown with a whitish band near the tip.

Described from a single specimen from Raleigh, N. C., taken in late May by Mr. Z. P. Metcalf, to whom I am indebted for the opportunity to describe it.

Scaphoideus immistus Say.

This species which stands as the type of the genus, was described by Say among the earlier descriptions of American insects, and was doubtless abundant at that time as it has been since. It is one of the most common species met with in many parts of the country, and its distribution is very extensive, specimens having been taken all the way from the Atlantic to the Pacific coasts. It is especially abundant in the Mississippi Valley and seems to occur on quite a variety of plants. Notwithstanding its abundance its life history and the food plants of the larval stages have not been determined, a fact which makes it difficult to assign any definite limitations to the numerous varieties of the species.

The species is one of the most variable in the genus, and some of the more definite of these varieties were described in my paper of 1900, but as stated in that paper, there are many other variations which defy description because of the insensible gradations represented between the different forms.

Scaphoideus luteolus Van D.

This species is pretty closely related to immistus, the characters for its separation being indefinite, but depending mainly on the characters of the claval veins and the male genitalia. The distribution has not been modified by recent collections and no further information regarding the life history has been secured.

Scaphoideus cinerosus Osb.

No further data have been secured regarding this species.

Scaphoideus melanotus Osb.

This species which appears to have been very rare and which has been known hitherto only from the specimens in hand at the time of the original description, two of which were from Texas and one

from Maryland, has recently been sent to me from Pennsylvania in some material submitted by the Carnegie Museum. This specimen agrees perfectly with the type material, so that it strengthens the impression as to the distinctness of the species. The most evident character is the intensely black face.

Scaphoideus opalinus Osb.

20th Report N. Y. State Entomologist, 1904, p. (1905).

This species was described from specimens taken in 1904 at Cold Spring Harbor, L. I., on red cedar, and it has been reported later from Riverton, N. J., Gowanda, N. Y., and Seven Oaks, Fla., by Mr. E. P. Van Duzee. The specimens from these different localities agree so perfectly with the type material that the species may be considered as well defined, although, as stated in my original description, it stands close to immistus in the immistus group.

Scaphoideus obtusus Osb.

No further undoubted specimens of this species have appeared since the original description, but Mr. Van Duzee has collected at Crescent City, Sanford, Seven Oaks, and Fort Myers in Florida, specimens which he is inclined to refer to this species. They appear to me to be somewhat closer to typical immistus than the type specimens of obtusus and so might be considered as connecting the form with that species; however, Mr. Van Duzee has taken one specimen at Lancaster, N. Y., which agrees distinctly with the type material, and so far as these specimens go there is a fairly distinct separation from immistus.

Scaphoideus festivus Mats.

Termesz Fuget, 25, p. 384, f. 14.

This species described by Matsumuri for Japan has been recorded for other parts of the oriental region, Ceylon and British India, and is probably somewhat generally distributed in the oriental region.

The species corresponds pretty closely with our immistus which it is said by Matsumuri to closely resemble and occupies for the old world about the same position that immistus does with us.

Aside from the above species, two other species of the genus have been described from the old world

Scaphoideus aegypticus Mats.

Jour. Coll. Sc. Un. Tokyo, 23, No. 6, p. 291, f. 7 (vide Oshanin).

The only locality cited is Egypt.

Scaphoideus horvathi Mats.

Jour. Coll. Sc. Un. Tokyo, 23, No. 6, p. 29, t1 f 7 (vide Oshanin).

Described from Algeria.

A NEW SPECIES OF TINOBREGMUS (Homoptera Jassidae).

HERBERT OSBORN.

Tinobregmus pallidus n. sp. Smaller than vittatus and without the stripes on the elytra nor the dark markings on the prothorax, but with a distinct terminal border on the elytra, dark brown or black. Underneath somewhat tinged with black. Female, length six millimeters to tip of ovipositor.

The vertex narrow as in vittatus, enlarging anteriorly, distinctly rounded to the front; front narrow, elongate, polished; clypeus elongate, widening toward the tip; the apex emarginate; beak equaling the clypeus in length and extending to hind coxae. Cheeks long, sinuate on the border; lorae narrow, elongate, extending half the length of the clypeus; prothorax short, hind border sinuate; elytra ovate, extending to the pygofer; veins rather indistinct; apical cells shortened.

Color, light yellowish or pallid with ivory luster, the vertex and prothorax unmarked, the front with a central lighter stripe bordered by brownish suffused stripes becoming darker on the clypeus; beak blackish at base and tip; elytra with a distinct black border at the apex, fading toward the disk; abdomen above irregularly marked with black; the pygofer with black at base and sides and along the inferior border; venter blackish with segments bordered with whitish; the ovipositor black.

Genitalia: Last ventral segment of female slightly sinuous, the hind border of ovipositor for extending about one-fourth its length beyond the pygofer.

Described from four specimens, all females, received from Mr. E. S. Tucker, and collected at Plano, Texas, May, 1907. This species at first sight closely resembles vittatus, but is distinctly smaller and lacks the characteristic markings of that species for the elytra, prothorax, vertex and front. Its food plant is not known.

PHLOX STOLONIFERA REDISCOVERED IN OHIO.

ROBERT F. GRIGGS.

Phlox stolonifera Sims., or as it is better known Phlox reptans Michx., was reported from Ohio by Riddell in his "Western Flora" in 1835 as occurring on "argilaceous hillsides." No more precise locality is given than the simple notation, "O., Ky." Since that time until the present season the plant has never been observed within the borders of the state and its known range, "The Allegheny region, Pa. to Ky. and Ga." gave no ground for expecting it in Ohio. For this reason Dr. Kellerman in making his "Fourth State Catalog of Ohio Plants" excluded it from the list. It was therefore a great pleasure to come upon a bed of it in full flower on Little Rocky Branch of Big Pine Creek in Hocking County, May 30, 1910, where it was growing in a deep cold Hemlock forest.

One is surprised that such a conspicuous plant as the present could have eluded the botanists so long. The reason is probably two-fold. The plant grows only in the wildest ravines in the most inaccessible part of the state. The place where it was first found has never been entirely denuded of its virgin timber. Moreover, it appears to flower rather infrequently as may be seen from the circumstances attending the discovery. The writer in company with Mr. B. B. Fulton had spent four days camping in the hills and had been tramping continuously through exactly similar country but it was not seen until the afternoon of the last day when two patches, the first flowering and the second not, were found. Later in the summer, however, after the vegetative stage of the plant had become familiar it was found to be common in similar situations all through the region traversed on the earlier trip. Had blossoms been abundant it could hardly have been overlooked, for on account of its stoloniferous habit, it everywhere grows in large beds. It must be remarked, however, that the spring of 1910 was marked by very severe frosts which destroyed the fruit crop, and may have adversely affected the buds of this plant so that further observations will be necessary to determine whether the lack of flowers was a usual or an accidental phenomenon.

Except for the Ohio station the species seems to be narrowly limited to the mountains. It also appears to be rare throughout most of its range, unless perhaps in Pennslyvania where it is cited by Porter without comment from five of the mountain counties. It does not extend into New York, however, but becomes rare before the northern boundary of Pennsylvania is reached. Dudley in the Lackawanna Flora knew of but two stations, Kingston and Forty Fort, from the first of which he cites a single plant and from the second a single bed. It occurs in the mountains which form the boundary between Kentucky and Virginia, being reported from near the line in both states. In Tennessee, Gattinger cites but one locality, Ducktown, Polk Co., and significantly adds another in southwestern Virginia. There are several stations in the mountains of western North Carolina. It reaches its southernmost limit in Alabama where it is reported from only one county Cullman, by Mohr, with the notation, "rare." If the species is as rare through its whole range as these citations would seem to indicate, it is a noteworthy exception to the general rule. In nearly all cases the "rare plants" of any region are merely on the edges of their ranges and in the proper places are common enough.

SOME REASONS WHY A NATURAL HISTORY SURVEY IS NEEDED IN OHIO.

The bill to be presented to the General Assembly providing for a Natural History Survey specifies in part the purposes of such a Survey, but some notes concerning the scope of such work, the reasons why it is needed and the extent to which such work is in progress in adjacent states may be desirable.

It will be generally recognized that the plant and animal life in a region such as Ohio must undergo marked changes as the result of the settlement and cultivation of the state, and some reflection upon the character of these changes must make it apparent that the record of the kinds of animals and plants that exist and that may be disappearing is desirable. Such forms have a distinct place in nature and the conditions under which they can flourish must be such as to affect other organisms of the same nature, and the recognition of these conditions may have the greatest importance in reference to the introduction of crops or of animals for economic purposes. Aside from this consideration, however, a knowledge of what has actually been in existence in the state has distinct scientific importance, and such knowledge may at any time be found to have a most important bearing on some questions vital to human interests. We know for instance, that the life of many of our streams is being greatly depleted either as a result of the contamination of water from the refuse of factories or other sources, or to other conditions less evident, and the disappearance of these forms of life in streams and lakes has a most important bearing upon the possibilities of growth for fishes and some other forms which have distinct importance to mankind. A careful survey and record, therefore, of what forms are now found in our streams, and comparison, so far as previous records makes it possible, with what has been present in the past, and careful future records as to the changes which may occur in the aquatic life of the state, will have a value that may be beyond estimate.

Aside from this economic feature, however, we may particularly consider the value that such a knowledge has in the educational work in every school in the state, and hence to the future citizens of the state. Without such knowledge teachers must depend upon statements made regarding the animal life of other localities, and even where this applies very closely to the conditions in our own state, the difficulty of securing the works in which such records are to be found makes it practically out of the question for the majority of teachers to take advantage of them. If all the teachers of Ohio could be furnished with definite information concerning the kinds of animals, birds, insects and plants that are

accessible in their immediate neighborhoods, they would have a basis for teaching which would be of the utmost service in their work. Such knowledge is more particularly in demand since there has been such a general movement in nature study, and so much demand for instruction in those branches which are closely related to agriculture and the industries.

In another direction such a survey is desirable because it is becoming known that many diseases have their means of transmission in the lower forms of organisms such as the fly, mosquito, flea, etc., and to the physician it is a matter of distinct importance to know what animals capable of bearing these diseases are to be found in the locality in which he is at work.

In connection with the distribution of plant life there is an important work to be done in recording areas of timber and the proportion of the different kinds of timber trees in the state. While this may in its details belong to a distinct division of forestry, the general distribution could naturally be determined in such a survey as is here contempleted, and unless provided for in other directions would be an important subject for study. The distribution of plants with special reference to soil and conditions would form a very important basis for the experimental work carried on by the state experiment station, and the necessity for such a Survey has been very pointedly urged by the director of the Experiment Station.

A feature of the proposed Survey that will concern the various schools in the state particularly is that of the distribution of the identified material through the schools, to form local collections in the colleges, city museums or high schools where they may be desired. Such a distribution is carried on in Illinois and has been a means of large service in the state. One advantage of this policy will be to distribute the services of the Survey widely over the state rather than to centralize a large collection in any one place. It means also that the different communities throughout the state will have an opportunity to co-operate with the Survey both in the collection of material, the preparation of reports, and in the direct use of the materials obtained.

Work of the kind here proposed is in progress in Connecticut, Vermont, Maryland, North Carolina, Alabama, New York, New Jersey, Pennsylvania, Indiana, Illinois, Wisconsin, Minnesota, Iowa, Nebraska, Kansas, Missouri, Michigan and probably some other states, and it will be noted that of the northern and central portion of the country Ohio stands alone in not providing for such work. The surveys in these different states are organized on somewhat varied lines, but in all cases provide for more or less of the work here proposed. In Connecticut the Survey is practically along the lines here suggested, although it does not provide for distribution of collections to schools. In New York it is carried on

under the State Museum of Natural History, which includes the work of several bureaus. In Pennsylvania it is provided for in the form of an office of state zoologist who collects material and makes frequent reports on progress. In Michigan the Biological Survey has been in force for a few years only, but its scope is practically the same as here outlined, except that no provision is made for the distribution of collections. In Indiana it is associated with the Geological Survey, but a large amount of work has been done upon the plant and animal groups. In Illinois where the work has been continued for some thirty years or more a great deal has been accomplished in determining the character and distribution of the organic life of the state, extended studies upon the food habit of birds, fishes and other forms have been carried through, and extended series of collections have been distributed to the high schools of the state. A number of very valuable reports have been published, many of them inaccessible to people outside of the state, except as they are distributed to the libraries or specialists. The organization in Illinois is termed the State Laboratory of Natural History but its scope is practically that of the Survey proposed for Ohio. It may be noted, however, that there is a movement started in that state for a further ecological survey which would enlarge the scope of the present work. In Wisconsin the Natural History Survey has been associated with the Geological Survey and has been in progress for over a quarter of a century, and the same may be said of Minnesota. In Iowa the present Survey has been in progress for about twenty years and the survey work of this character in Missouri, Kansas and Nebraska has been carried on to about the same extent.

In Ohio practically nothing in this direction has been done since the publication of the reports on birds, mammals and fishes in the earlier Geological Survey reports, except such as has been done by individuals. As these older reports are now not only inaccessible but are entirely out of date the data presented in them is of service only so far as it may serve as a record for the time of its publication. The need of a definite Biological Survey was urged in the report of Director Thorne for the year 1890, but apparently no definite steps were taken to organize or provide for such a survey. The Ohio Academy of Sciences has during the last fifteen years through the efforts of individual members published a number of papers upon local collections or materials representing a greater or less portion of the state, a considerable number of these having been provided for by the generosity of Mr. Emerson McMillen. These studies, however, have necessarily been restricted in their scope, and of course without any correlation or connected effort on the part of different individuals to make their studies blend into a systematic study of the state at large. In fact such a systematic study of the state at large cannot be hoped

for except under some arrangement which will provide for a general direction and the means for carrying investigations into all sections of the state where it is necessary to secure the material for such a complete Survey. While the amount called for in the present bill is very modest as compared with what is expended in some other states, it is believed that with the numerous trained workers whose time could be employed for certain periods, that a great amount of work could be accomplished, provided it be connected and the results brought together in systematic form published in such manner as to be capable of distribution to those persons in the state who desire it.

HERBERT OSBORN.

The Tallant Collection. The Department of Zoology and Entomology of the Ohio State University has recently received as a donation a fine collection of Lepidoptera from Mrs. Catherine Tallant of Richmond, Indiana. The collection was made by Mr. W. N. Tallant during a series of years in the nineties and up to about 1905. It contains mainly species occurring in central Ohio, especially at Columbus, where Mr. Tallant resided for a number of years, but has also a number of species from different parts of the United States, and also some fine examples of species occurring in South America, Japan, China, India, Ceylon, and Africa. The collection contains about 10,000 specimens in most excellent condition, very beautifully mounted, and many of the species contain very full series, showing variations, etc., which will make them of special value for scientific study. They are, for the most part, carefully identified, included in good cases and cabinets, and will be kept under the name of the "Tallant Collection."

Taken with the other collections in Lepidoptera, the collection of Odonata left by Professor Kellicott, and those in various groups which have been accumulated by the efforts of the members of the Department, the University is now provided with an excellent collection of insects, including representatives in all the different orders, the total number of specimens probably coming close to 100,000.

H. O.

NOTES ON A COLLECTION OF BOLETACEAE.*

BRUCE FINK.

The summer of 1909 was favorable for the development of fleshy fungi on account of the unusually large rainfall. During the first part of August, the writer was at "Beechwood Camp" with a party of students. The month was very wet, and fleshy fungi were brought in and studied in large numbers. The tables were daily covered with an array of Russulae, Lactariae, Amanitae, Boleti, and other forms, which altogether gave an assortment of forms, sizes, and colors seldom seen in these days of depleted forest lands. While students were working on the agarics, the writer gave his attention to the Boletaceae, collecting and making careful notes of each species. The result was fourteen species, some of them not previously reported from Ohio.

"Beechwood Camp" is located in an almost virgin forest, five miles north of Oxford, Ohio. Beech trees form the facies over all the area, except the flood-plain of Tallawanda Creek, where these are replaced by the plane (sycamore) trees. The forest covers 200 acres. Large trees abound, and many trees have been allowed to fall and decay, so that stumps and logs are abundant, on which fungi are plentiful in wet weather.

After the collecting was done at "Beechwood Camp," the last two weeks of August were spent in the foothills of the Cumberland Mountains, east of Berea, Kentucky. The rainfall had been abundant there also, and the fleshy fungi were growing in such size and profusion as we can never hope to see again in Ohio, since the forests are so largely removed. Special attention was again given to the Boletaceae and twenty-four species were collected, several of which were unknown from Kentucky. Some of the species collected contained specimens of unusual size, plants twenty cm. across being collected several times.

Twenty-eight (28) species were collected in the two localities, during the month. This is not a large number; but the Boletaceae are rare plants, and only seventy-five species are given for North America, including the West Indies.

Thanks are due to a number of persons for aid in the work. Mr. Hugh Willard Fink was a companion and efficient aid in nearly all of the collecting, and acted as scribe in the note-taking. Indeed, without the help that he was able to give, the work done could not have been accomplished in the time at hand. Professor G. D. Smith, of Richmond, Kentucky, was present during the study in the Kentucky locality, and aided in the collecting and photographing and in becoming acquainted with the plants.

* Reported at the meeting of the Ohio Academy of Science, Akron, Nov. 25, 1910.

Mr. W. G. Stover aided considerably in the collecting and study at "Beechwood Camp." After the plants were collected, described in the field, preserved and studied, duplicates were sent to Dr. W. A. Murrill, who helped with verifications, corrections and determinations.

Full sets of the plants may be found in the herbarium of the writer, and in that of the New York Botanical Garden.

Professor Smith found the rather rare Fistulina pallida on an oak stump in the Kentucky locality

All of the specimens were collected on soil, unless otherwise stated.

LIST OF SPECIES.

Gyroporus castaneus (Bull.) Quel. Ench. Fung. 161. 1886.
Boletus castaneus Bull. Herb. Fr. pl. 328. 1786.

In beech woods, Oxford, O. No. 2.

Tylopilus felleus (Bull.) P. Karst. Rev. Myc. **39**: 16. 1881.
Boletus felleus Bull. Herb. Fr. pl. 379. 1787.

Usually along edges of woods. Big Hill, Ky. Nos. 19, 24. 39, 40, 40a and 41. Also collected in woods near Oxford, O., during the summer of 1910. Some of the specimens were very large, the largest reaching 20 cm. across the pileus.

Tylopilus indecisus (Peck) Murrill, Mycologia **1**:15. 1909.
Boletus indecisus Peck, Ann. Rep. N. Y. State Mus. **41**:76. 1888.

In woods, Oxford, O. Nos. 3, 3a, 7 and 17. Big Hill. Ky. Nos. 17 and 31. Not common in either locality.

Ceriomyces russellii (Frost) Murrill, Mycologia **1**:144. 1909.
Boletus russellii Frost, Bull. Buffalo Soc. Nat. Sci. **2**:104. 1874.

In woods, Big Hill, Ky. No. 37. Rare.

Ceriomyces betula (Schw.) Murrill, Mycologia **1**:144. 1909.
Boletus betula Schw. Schr. Nat. Ges. Leipzig **1**:90. 1822.

In moist ravines in woods, Big Hill, Ky. No. 38. Infrequent. Said to be the same as Boletus morgani Peck, Bull. Torr. Bot. Club **10**:73. 1883. Regarded by some to be the same as Boletus russellii Frost, Bull. Buffalo Soc. Nat. Sci. **2**: 104. 1874, but the two are not to be confused in the field.

Ceriomyces auriporus (Peck) Murrill, Mycologia **1**:147. 1909.
Boletus auriporus Peck, Ann. Rep. N. Y. State Cab. **23**:133. 1873.

In beech woods, Oxford, O. No. 16. Rare. In woods, Big Hill, Ky. Nos. 16, 20, 34, 36, 57, and 64. Frequent. No. 36 included some unusually large specimens with the pileus 7 cm. across.

Ceriomyces auriflammeus (Berk. & Curt.) Murrill, Mycologia **1**:147. 1909.
Boletus auriflammeus Berk. & Curt. Grevillea **1**:36. 1872.

In pine woods, Big Hill, Ky. No. 25. Also in mixed woods. Infrequent. The striations of the stipe were much elongated.

Ceriomyces eximius (Peck) Murrill, Mycologia **1**:148. 1909.
Boletus eximius Peck, Journ. Mycol. **3**:54. 1887.

In woods, Big Hill, Ky. No. 56. Rare.

Ceriomyces crassus Batt. Fung. Hist. 62. 1755.

In mixed pine woods, Big Hill, Ky. Nos. 32, 32a, 48, 51 and 67. Frequent. The plants under the last number differed considerably and may not belong here. The largest specimens reached 20 cm. across the top of the pileus.

Ceriomyces affinis (Peck) Murrill, Mycologia **1**:149. 1909.
Boletus affinis Peck, Ann. Rep. N. Y. State Mus. **25**:81. 1873.

In pine woods, Big Hill, Ky. No. 49. Not common.

Ceriomyces curtisii (Berk.) Murrill, Mycologia **1**:150. 1909.
Boletus curtisii Berk.: Berk. & Curtis Ann. Mag. Nat. Hist. II. **12**:429. 1853.

In mixed pine woods, Big Hill, Ky. No. 30. Infrequent.

Ceriomyces inflexus (Peck) Murrill, Mycologia **1**:150. 1909.
Boletus inflexus Peck, Bull. Torr. Bot. Club **22**:207. 1895.

In mixed pine woods, Big Hill, Ky. No. 28. Infrequent.

Ceriomyces retipes (Berk. & Curt.) Murrill, Mycologia **1**:151. 1909.
Boletus retipes Berk. & Curt. Grevillea **1**:36. 1872.

Open grassy woods, Oxford, O. No. 11. Very rare. In woods Big Hill, Ky. Nos. 23 and 50. Common.

Ceriomyces miniato-olivaceus (Frost) Murrill, Mycologia **1**:152. 1909.
Boletus miniato-olivaceus Frost, Bull. Buffalo Soc. Nat. Sci. **2**:101. 1874.

In beech woods, Oxford, O. Nos. 9 and 18. Infrequent. Both collections were considered uncertain by Dr. Murrill.

Ceriomyces bicolor (Peck) Murrill, Mycologia **1**:152. 1909.
Boletus bicolor Peck, Ann. Rep. N. Y. State Museum **24**:78. 1872.

In beech woods, Oxford, O. No. 15. Rare. The plants were only about 3.5 cm. across the pileus. In woods, Big Hill, Ky. Nos. 22, 29, 42, 45 and 53. Common. Plants were larger, often reaching 12 or 15 cm. across the pileus.

Ceriomyces pallidus (Frost) Murrill, Mycologia **1**:152. 1909.
Boletus pallidus Frost, Bull. Buffalo Soc. Nat. Sci. **2**:105. 1874.

In woods, Big Hill, Ky. No. 46. Rare.

Ceriomyces subtomentosus (L.) Murrill, Mycologia **1**:153. 1909.
Boletus subtomentosus L. Sp. Pl. 1178. 1753.

In woods, Big Hill, Ky. No. 35. Rare.

Ceriomyces fumosipes (Peck) Murrill, Mycologia **1**:154. 1909.
Boletus fumosipes Peck, Ann. Rep. N. Y. State Mus. **50**:108. 1897.

In beech woods, Oxford, O., Nos. 5 and 6. Infrequent. In woods, Big Hill, Ky. No. 59. Rare.

Ceriomyces communis (Bull.) Murrill, Mycologia **1**:155. 1909.
Boletus communis Bull. Herb. Fr. pl. 393, A. C. 1788.

In beech woods, Oxford, O. Nos. 4, 12 and 13. In woods, Big Hill, Ky. Common and most often found where logs have rotted.

Suillellus luridus (Schaeff.) Murrill, Mycologia **1**:17. 1909.
Boletus luridus Schaeff. Fung. Bavar. **3**:pl. 107. 1770.

In woods, Oxford, O. Nos. 1 and 14. Infrequent. Big Hill, Ky. Nos. 26, 43, 44, 54, 60, 61 and 65. Frequent and variable. No. 44 is a peculiar form with pileus of a dull olivaceous brown color, and the mouths of the tubes a dark maroon, even in young specimens, and blackening where bruised. This has a very different appearance from the others, but was placed here by Dr. Murrill. In No. 65 the mouths are a pale pink. In No. 61 the pileus was reddish pink. Some of these forms have been commonly placed under Boletus purpureus Ach. Bol. 11. 1835.

Suillellus frostii (Russell) Murrill, Mycologia **1**:17. 1909.
Boletus frostii Russell; Frost, Bull. Buffalo Soc. Nat. Sci. **2**:102. 1874.

In woods, Big Hill, Ky. No. 27. Common at all elevations.

Suillellus rubinellus (Peck) Murrill, N. Am. Fl. **9**:152. 1910.
Boletus rubinellus Peck, Ann. Rep. N. Y. State Mus. **32**:33. 1880.

In young pine woods, Big Hill, Ky. No. 33. Very numerous.

Suillellus morrisii (Peck) Murrill, N. Am. Fl. **9**:153. 1910.
Boletus morrisii Peck, Bull. Torr. Bot. Club **36**:154. 1909.

In mixed pine woods, Big Hill, Ky. No. 66. Rare.

Rostkovites granulatus (L.) P. Karst. Rev. Myc. **39**:16. 1881.
Boletus granulatus L. Sp. Pl. 1177. 1753.

In woods, Big Hill, Ky. Nos. 62 and 68. Rare.

Strobilomyces strobilaceus (Scop.) Berk. Outl. Brit. Fungol. 236. 1860.
Boletus strobilaceus Scop. Anni. Hist. Nat. **4**:148. 1770.

In woods, Oxford, O. No. 8. Big Hill, Ky. No. 70. Common in both localities.

Boletinellus merulioides (Schw.) Murrill, Mycologia **1**:7. 1909.
Daedalea merulioides Schw. Trans. Am. Phil. Soc. II. **4**:160. 1832.

In beech woods, Oxford, O. No. 10. On or about decaying sticks or roots. Rare. About two dozen plants were collected on the campus of Miami University in July, 1910.

Boletinus berkeleyi Murrill, Mycologia **1**:6. 1909.

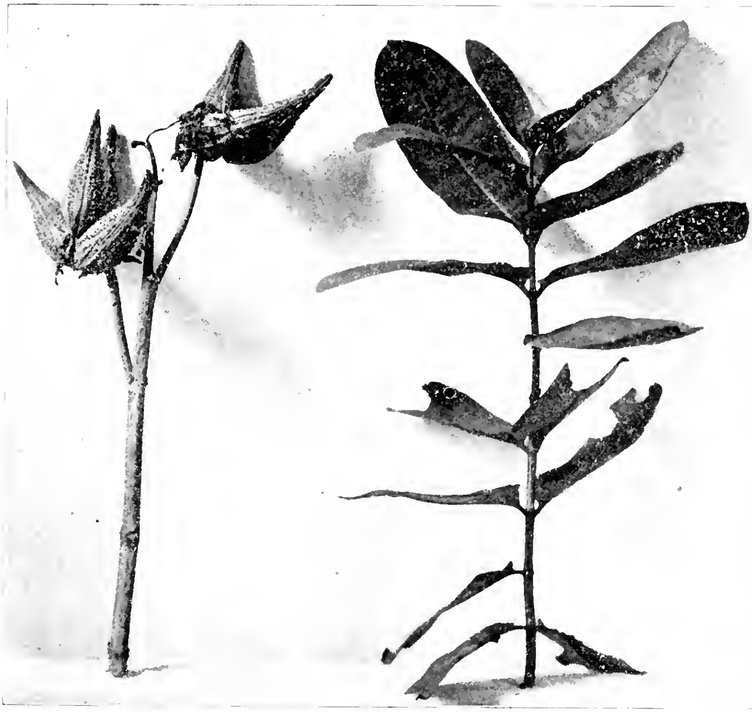
In oak woods, Big Hill, Ky. Nos. 21 and 55. Rare.

Miami University.

OHIO GROWN RUBBER, CROP OF 1910.*

CHARLES P. FOX.

Product of Common Milkweed (Asclepias syriaca). A common plant belonging to the Asclepiadaceae; found abundantly throughout the United States; classed as a weed, convicted as a bee-killer, advocated as a rubber producer. Too well known to need description.



Asclepias syriaca.

Latex. Milk-like, thin; acid or neutral reaction; characteristic odor of milkweed; does not coagulate on standing in a closed vessel; imperfectly coagulated by acids; thickened or partially coagulated by ammonia; coagulated by heat; coagulated by alcohol.

* Presented at the Twentieth Annual Meeting, Ohio Acad. of Sci., Akron, Nov. 25.

Coagulated Latex. The coaglum is plastic and can be moulded into cakes resembling some of the cheaper grades of rubber. The whey contains mineral matter and sugar.

Caoutchouc. Obtained from the coaglum. Is flabby; lacks strength and firmness; is high in gravity. Responds to the sulfur chloride and bromine tests. Yield of rubber, on basis of latex, is 2 to 3%.

Resin. White, tasteless, odorless. Gives "asclepione," described by Watts as "radiating crystals insoluble in water and alcohol, and is not attacked by dilute caustic."

This plant has been suggested as a source of crude rubber. The project has engaged the serious attention of several parties during the past twenty years. A careful study of the question, covering a period of twelve years, indicates that while rubber is a product of the plant, the **amount** is so **small,** its **quality** is so **inferior,** and its **cost of production** is so high, that a profitable industry is out of the question.

Orton Hall, October 3, 1910.

The meeting was called to order by the President, and the minutes of the previous meeting were read and approved.

Professors J. H. Schaffner, J. S. Hine, and J. A. Hambleton were appointed to act as a committee to nominate officers for the year.

The program consisted of reports on Summer Work by the members.

Prof. W. R. Lazenby made some observations on the trees, and spoke of the scarcity of seed this year.

Prof. Schaffner spoke of his observations on leaf markings, and the relation of plants to the substratum.

Prof. Hine carried on his study of the mammals of the state during the summer.

Prof. Hambleton spent the most of the summer at the Lake Laboratory.

Miss Detmers gave a few observations on her work at Buckeye Lake.

C. L. Metcalf reported good early collecting this year for the entomologist, his special group being the Syrphidae.

B. W. Wells spent the earlier part of the summer at the Lake Laboratory.

B. F. Fulton made some observations on birds.

Lionel King reported a profitable summer at the Botanical Gardens in Cleveland.

M. G. Dickey, Secretary.

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TABLE OF CONTENTS.

A REVIEW OF LITERATURE ON THE GEOLOGY OF SOUTH AMERICA.

C. R. STAUFFER.

ARCHEOZOIC AND PROTEROZOIC (PRE-CAMBRIAN)

The pre-Cambrian of South America is mainly limited to three regions:

(a) Guiana, including portions of northern Brazil and southern Venezuela.

(b) The highlands of eastern and southern Brazil.

(c) Narrow strips in the Andes lying north of 40° S. latitude, together with similar strips running north and east from the main chain in northern Venezuela. These Andean strips may be of much later age, but they have been referred to the pre-Cambrian.

The first of these regions includes an area of more than 500,000 square miles of elevated broken land. It is separated from the Atlantic coast by a 10 to 70 mile wide strip of post-Tertiary sands and gravels, is (according to Crosby) bordered on the north and west for a distance of 800 miles by the Orinoco River, and to the south dips under Paleozoic and more recent sediments along a line which Derby draws approximately "from the mouth of the Amazonas, in latitude 1° N., to the confluence of the Rio Negra and Rio Brancho, between 1° and 2° S. latitude."[1]

The rocks of this region Crosby has grouped together in somewhat the following manner:

Pre-Cambrian

(4) ——— Semi-crystalline schists and marbles.

Great unconformity

(3) Montalban series. Gneisses and schists cut by coarse granite dikes. Garnets common.

(2) Huronian series. Quartz porphyry and felsite associated with various hornblende and slaty rocks showing distinct bedding.

(1) Laurentian series (?). Granite and some syenite.[2]

1. Crosby, W. O., Proc. Boston Soc. Nat. Hist., Vol. XX, 1881, p. 484.
2. Crosby, W. O., Loc. cit., p. 493.

No thicknesses are given and the value of the classification is perhaps questionable, but it appears to be the most complete of any thus far in print.

Concerning the semi-crystalline schists and marbles (No. 4 of the above section), Crosby says they "represent a horizon near, but below, the boundary line between the Eozoic and Paleozoic." And the granite (No. 1) "lies at the base of all the rocks of the colony (British Guiana) and coarse veins of it have pierced all the overlying formations including even the sandstone in one place."[3] This rock is identified as Laurentian in age but it either includes younger intrusives or is itself much younger, as the sandstone said to have been cut by it is identified as Triassic. At some places the granite is said to show a gneissic structure and again to pass over into distinct gneiss.

These old crystalline rocks are thought to have been above the sea in earliest Paleozoic time, but that they have not remained above throughout all the succeeding time is suggested by the great mass of Triassic sandstones capping the hills over 10,000 square miles of British Guiana.

The pre-Cambrian rocks of the highlands of eastern and southern Brazil cover a much larger area and, as in the former area, are in part covered by undetermined later formations. They extend over more than 30° of latitude and 25° of longitude. Here, as to the north, two great divisions of the rocks are represented. These consist of "two very distinct series, of which one, the most ancient, consists of crystalline rocks, including gneiss, gneiss-granite, and syenite, and the other more modern, of altered, but in general non-crystalline rocks consisting of quartzites, metamorphic schists and crystalline limestones."[4] The section is essentially the same as that given for the Guiana region and the same great unconformity is recognized. The transitional rocks above the unconformity are mainly quartzites and schists, with some argillite, crystalline limestone and bedded iron ores. The quartzite frequently passes over into ordinary sandstones, among which is the well-known flexible sandstone—itacolumite.

As an evidence of the age of the land-surface in this part of Brazil, Branner says that "the fine-grained gneiss in the vicinity of the city of Theophilo Ottoni, is so deeply weathered that one seldom sees a hard rock face."[5] The street and railroad cuts are made in the decomposed rock. At one place near the railroad station, the rock cut is 10 meters in depth and the schists stand as a perpendicular cliff, although so much decayed that one can thrust a knife into them anywhere.

3. Loc. cit., p. 493.
4. Derby, O. A., Proc. Amer. Phil. Soc., 1879, pp. 155-178, 251-258.
5. Proc. Wash. Acad. Sci., Vol. II, 1900, p. 187.

On the Pacific slope of the Andes from Patagonia northward the old formations show a similar three-fold division and are said to have essentially the same characteristics. It is probable, however, that these formations are of much later age.

PALEOZOIC.

The Lower Paleozoic Rocks. The lower Paleozoic formations of South America are not always recognizable and are perhaps wanting in some regions where later formations occur, but it is probable that a portion of the crystalline schists, quartzites and slates which have been referred to the pre-Cambrian are in reality early Paleozoic formations. In the Amazon region Derby says that the Silurian rests unconformably "on an extensive series of quartzites superior to"[6] the gneiss, but the age of this assemblage of rocks is not suggested. In this same region Katzer maps the Silurian as unconformable on a series of metamorphic rocks[7], which appear to be of pre-Cambrian age.

In Bolivia and northwestern Argentine occur outcrops of sandstones and quartzites in which a fauna of Upper Cambrian age (*Agnostus*, *Olenus*, *Conocoryphe* and *Ptychoparia*) has been collected.[8] The base of this series of rocks is not exposed and its thickness is unknown. In this same general region (Bolivia and Argentine) the Ordovician is represented by yellow argillaceous or quartzitic sandstones and black shales which are thought to represent the same horizon as the Orthoceras limestone (base of Ordovician) of the Baltic.[9] Among the fossils collected from this horizon are *Illaenus*, *Orthoceras* and *Endoceras* from the sandstone, and four genera of graptolites from the black pyritic shales exposed along Rio Corauhuata at Culi, Bolivia.[10] DeLapparent says this same fauna also occurs near Lima, Peru; and again along the coast of Venezuela between Caracas and Puerto Cabello, the finding of Ordovician fossils, among which is *Calymene senaria*,[11] indicates the presence of this system.

Silurian rocks are reported to occur along the coast of Chili but they are highly metamorphosed[12] and have not been well described. In southwestern Brazil, southern Peru and northwestern Argentine the Silurian rocks outcrop almost continuously

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6. Derby, O. A., Amer. Jour. Sci., 3d ser., Vol. XIX, 1880, p. 324.

7. Katzer, Friederich, Grundzuge der Geologie des unteren Amazonasgebietes, 1903, (Leipzig), p. 216.

8. Kayser, E., Beitrage zur Kenntniss einiger palaeozoisher Faunen Sudamerikas (Reviewed by Frech). Neues Jahrbuch fur Mineralogie, Geologie und Palaeontologie. Band II, 1898, p. 472.

9. DeLapparent, A., Treaté de Geologie, Tome III, p. 808.

10. Evans, J. W., Quart. Jour. Geol. Soc. London, Vol. LXII, 1906, p. 431.

11. Drevermann, Neues Jahrbuch, Band I, 1904, p. 91.

12. Forbes, David, Quart. Jour. Geol. Soc. London, Vol. XVII, 1860, p. 61.

over a region extending from northwest to southeast more than 700 miles and including an area of 80,000 to 100,000 square miles. These rocks form the mountain chain of the highest Andes, rising to a maximum elevation of 25,000 feet above sea-level.[13] In Peru they consist of blue to gray and black clay slates, shales and graywackes, with a subordinate amount of sandstone. East of La Paz the Silurian is thought to be fully developed and here Forbes estimated its thickness at 15,000 feet,[14] but it is quite probable that this includes also the Ordovician and a portion of the Cambrian.

Near Hanco in northwestern Argentine the Silurian is about 4,000 feet thick and consists of bluish gray to yellowish rough uneven-bedded limestone interstratified with marl, and all quite fossiliferous.[15] The Silurian strata of the Bolivia-Brazil-Argentine region are not very much folded but are faulted, tilted and often cut by intrusions of granite, porphyry, diorite, trap, etc., and in the vicinity of these masses the strata are altered into gneissic and schistose rocks whose sedimentary origin is only occasionally to be recognized.[16] Important veins carrying gold, silver, lead, tin, copper, zinc, nickel, etc., occur in the Silurian rocks and are thought to have been formed prior to the extrusion of the post-Paleozoic lavas.

In the Lower Amazon region Silurian strata outcrop on the Guiana side in a narrow strip (4± miles wide) along the southern margin of the metamorphic rocks, from the Rio Trombetas nearly to the Atlantic Ocean. On the river mentioned they have been studied to some extent and a considerable fauna collected (*Orthis, Lingulops, Tellinomya, Anodontopsis*).[17] Here they consist of about 1,000 feet of hard argillaceous and fine-grained micaceous sandstone, with some shale between the layers and about twenty feet of schists at the bottom, resting unconformably, at one place on felsite and at another on syenite.[18]

At the Morro do Cachorro the Silurian sandstones have a grayish, yellowish or reddish color, are often banded, and dip to the S. SW. at an angle of 5°. They frequently contain impressions similar to those recognized in the Medina of North America

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13. Forbes, David, Ibid., p. 53.

14. Forbes, David, Ibid., p. 61.

15. Bordenberger, W., Leitschrift der deutschen geologischen Gesellschaft, Band XLVIII, 1896, pp. 743–772.

16. Forbes, David, Loc. cit., p. 61.

17. Clarke, J. M., The Paleozoic Faunas of Pará, Brazil; Archivos do Museu Nacional do Rio de Janeiro, Vol. X, 1900, pp. 1–24.

18. Derby, O. A., Proc. Amer. Phil. Soc., Vol. XVIII, 1879, pp. 167–169.

under the name *Arthrophycus harlani* Con.[19] and hence may be the upper part of the Ordovician. Silurian strata are recognized by fossils to the north of the river only. Those called Silurian to the south are identified as such by their petrographic appearance and stratigraphic occurrence.

Devonian. The Devonian of South America is known in Brazil, Peru, Bolivia, Argentine and the Falkland Islands.

In Brazil strata referred to this system are found in the state of Pará on both sides of the Lower Amazon; in the province of Mato Grasso in central Brazil and the province of Paraná in southern Brazil.[20] In the Lower Amazon region it is best exposed on the north side of the valley where it forms a narrow belt along the border of the Silurian. O. A. Derby divided the Devonian of this region into three groups[21] as follows: The Maecurú, consisting of about 30 feet of massive coarse white or yellowish sandstone which is sometimes hard and sometimes a mere bank of sand. It contains an abundance of well-preserved fossils. This group rests on the Silurian, perhaps conformably, and is followed by the Erere group consisting principally of thin-bedded fine-grained micaceous sandstone with a subordinate amount of black shale. These sandstones are generally white in color but weather red, while the shale weathers to a whitish color. Near the base some cherty sandstone occurs. The whole group is quite fossiliferous and those forms occurring in the shale are different from those in the sandstone. Derby says there are thirteen distinct beds and the total thickness is about 200 feet. Above this lies the Curuá group, consisting, in the lower part, of about 300 feet of well-laminated almost slaty black shale, with concretionary beds containing the cone-in-cone structure and having a strong odor of petroleum. In the upper part the group consists of an equal amount (300 feet) of chocolate colored shale mottled with spots of a darker color and banded parallel to the bedding with various colored layers. This rock is mostly a clay mixed with much finely divided mica and sand. The lower part of these red-brown shales and the upper part of the black shales are abundantly marked with *Spirophyton.* This group is followed by about 50 feet of coarse sandstone of undetermined age and then follows (upper) Carboniferous rocks with distinctive fossils.

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19. Katzer, Friederich, Grundzuge der Geologie des unteren Amazonasgebietes, 1903, p. 216.

20. Thomas, Ivor, Zeitschr. d. deutsch. Geol. Ges., Vol. 57, 1905, p. 234.

21. Proc. Am. Phil. Soc. for 1879, pp. 169–171.

A more recent, although less detailed section of the Maecurú valley is given by Friedrich Katzer[22] as follows:

Carboniferous.
    Unconformity.
Devonian.
    6. Black shale.
    5. Red micaceous sandstone. The upper fossil-bearing horizon.
    4. Darker sandstone.
    3. Hornstone.
    2. Spirifer sandstone. The principal fossil-bearing horizon.
    1. Thin-bedded sandstone interbedded with shale.
Silurian.

Mr. Schuchert makes the hornstone of the above section the dividing line between the lower and upper Devonian[23] of the lower Amazon and on the basis of fossils refers that below to the age of the Oriskany and that above to Hamilton. In this he follows Katzer. The Devonian of this region is frequently faulted, but only slightly folded and often cut by diabase dikes. In the province of Mato Grasso the horizon of the Devonian exposed is not known but it is probably that of the lower part of the Maecurú group, as indicated by the few fossils collected. The same horizon is reported from Paraná[24] where the deposits are principally brown and black shales.

The Devonian of Bolivia, east of Lake Titicaca, consists principally of yellowish to gray sandstones and black shales. Only in the strongly folded part of the Cordillera does the rock take on a graywacke character. The Devonian is easily distinguished from the underlying Silurian by its never failing mica content, and by its normal sedimentation from the overlying salt and gypsum-bearing red sandstones of the Cretaceous. The Devonian is overlain by Carboniferous only in the northern part of Bolivia.[25] These rocks are all highly fossiliferous and are thought to represent the Oriskany sandstone, the Onondaga limestone and the Hamilton beds of North America.[26]

In Argentine the Devonian is well exposed in the region of Rio del Jachal. On the east side of the river the system is 400 meters thick and consists of 200 meters of unfossiliferous shales, above which lies 200 meters of shales and graywackes with three fossiliferous horizons. To the west of the Jachal two other outcrops occur. Here the Devonian consists of 2,000 to 3,000 meters

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22. Grundzüge der Geologie des Amazonasgiebetes. 1903 (Leipzig), p. 191.

23. Jour. Geol., Vol. XIV, 1906, p. 731.

24. Thomas, Ivor, loc. cit., p. 238.

25. Knod, Reinhold, Neues Jahrbuch fur Mineralogie, Geologie, und Palaeontologie, Vol. 25 (Beilage Band), 1908, pp. 574, 575.

26. Steinmann, Gustav, Am. Nat., Vol. 25, p. 856.

of graywacke, sandstone, quartzite and shale with a subordinate amount of limestone.

In the Falkland Islands at Cerro del Fuerto the Devonian rests conformably on the Silurian and consists chiefly of micaceous red sandstones.[27]

The fauna of South America is closely related to that of North America. This is shown, especially, by the presence of such forms as *Chonetes coronatus* and *Tropidoleptus carinatus* in the lower Devonian, which occur later in the Hamilton of North America.

Carboniferous and Permian. The Carboniferous formations are apparently more restricted in South America than the Devonian, but occur in the same general regions.

The Lower Carboniferous (Mississippian) is made up, in large part, of non-fossiliferous sandstones. The Upper Carboniferous (Pennsylvanian) is largely marine and contains representatives of widely distributed brachiopods and gastropods. Fusulina limestones occur in Peru, Bolivia and Brazil.[28]

In the lower Amazon region Carboniferous strata (probably both Mississippian and Pennsylvanian) are well exposed. These beds seem to be unconformable on the older formations[29] but dip with them into the Amazon embayment. Along the Rio Tapajoz, north of Itaitúba in the province of Pará, the system is composed of green shales at the bottom which are followed above by coarse black shales with numerous concretions (septaria). These shales are succeeded by laminated green, white, and red arenaceous shales and sandstones and capped by more than 60 feet of limestone.[30]

In the provinces of Paraná and Santa Catharina, southern Brazil, the Carboniferous rests unconformably on the Devonian, or sometimes on the granite itself. In the lower part is a coarse conglomerate, but from this upward the succession is continuous through the Trias without any great unconformities. I. C. White includes the Carboniferous, Permian and Triassic in the Santa Catharina system.[31] His classification of the former two is as follows:

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27. Thomas, Ivor, loc. cit., p. 244.

28. Steinman, Gustav, Amer. Nat. ,Vol. XXV, 1891, p. 856.

29. Kayser, Emanuel, Lehrbuch der Geologie, 3d Ed., Vol. II, 1908, p. 238.

30. Hartt, C. F., Bull. Cornell Univ., Vol. I, No. 1, 1874, p. 29.

31. Commissao de Estudos das Minas de Carvao de Pedra do Brazil Relatorio Final, 1908, p. 33.

System	Series	Formation	Thickness	Total
Santa Catharina System	Sao Bento series (Triassic)	Sandstones, shale and eruptives	900 m.	
	Passa Dois series (Permian)	Rocinha limestone	3 m.	223 m.
		Estrada Nova, gray and variegated shales with cherty concretions and sandy beds	150 m.	
		Iraty black shale (contains *Mesosaurus* and *Stereosternum*)	70 m.	
	Tubarao series (Permo-Carboniferous)	Palermo shales	90 m.	180 m.
		Rio Bonito shales and sandstones (Coal Measures and Glossopteris flora)	158 m.	
		Orleans conglomerate	5 m.	
		—— yellow sandstones and shales to granite floor	27 m.	

The lower member of the Carboniferous consists of sandstones and shales resting on the granite. Overlying these is the Orleans conglomerate which is made up of "boulders of granite, quartzite and other hard rocks, some of which are 20 to 25 cm. in diameter" imbedded in clay. This conglomeratic character is common throughout southern Brazil. At "several localities near Rio Negro, 10 kilometers from any outcrop of granite," it contains "granite boulders in vast numbers up to 3 meters in diameter, all imbedded in a fine and apparently unstratified gray muddy sediment."[32] White thinks this deposit corresponds in age to the Dwyka conglomerate (Permian) of South Africa, to which it bears much resemblance, and that it is of glacial origin.

The Rio Bonito beds (Coal Measures) consist of partly consolidated yellowish and grayish white sandstones interbedded with gray shales and several beds of coal. The coals of Brazil are all poor. In the lower part of the Rio Bonito beds is the Bonito coal, locally making up most of the formation. Its thickness frequently runs as high as 2.5 and even 3.22 meters and is quite persistent in the Minas region, but it contains much shale and the coal is of poor quality.

Above the Bonito coal bed is a horizon containing many plant remains, among which the abundant fossils belong to the genera Sigillaria and Glossopteris.[33] The only other important coal bed

32 White, I. C., loc. cit., p. 51.

33. White, I. C., loc. cit., p. 79.

is the Barro Branco bed, much higher in the formation. It also consists of seams of coal separated by thin layers of shale.

The Palermo shales lie conformably (?) on the Rio Bonito beds and are made up of soft gray and red shales.

Since the Permian is thought to be conformable, or essentially so, on the Carboniferous, the shales, limestones and cherts of the Passa Dois series may be considered here.

The Iraty black shale, which is a widely persistent formation, is distinguished by its Reptilian remains and by the ever present odor of petroleum. It contains nearly 20% of volatile matter and 9% of carbon.

The Estrado Nova beds consist of gray and variegated shales with some sandstones.

The Rocinha limestone is the top of the Permian and forms a persistent dividing line between it and the Triassic.

In northwestern Argentine there is a series of sandstones and shales with some coal which are at least in part Carboniferous. They lie unconformably on the older Paleozoic rocks (Devonian?) and are overlain conformably by the Triassic as in southern Brazil The Glossopteris flora also occurs here.[34]

Rocks of (Upper and Lower) Carboniferous age are found in Bolivia in the vicinity of La Paz and north of Lake Titicaca. The system is made up of red sandstones, red and green shales, and some limestone. Some layers have a rich fauna which was at least locally of marine Pennsylvanian age.[35] The brown and red sandstones and conglomerates belonging to the Permian of Peru carry a considerable amount of copper which is thought to have been an original deposit. Salt and gypsum beds are also abundant.[36]

Strata carrying the Glossopteris flora occur in the Falkland Islands.

MESOZOIC.

Triassic and Jurassic. The Permian, Triassic and Jurassic of South America are very closely related and sometimes inseparable. Most of the continent was above sea-level throughout these periods, but probable land formations of this age are known at several localities in Brazil, while marine Triassic and Jurassic occur in the Cordilleras between 5° and 35° south latitude.[37]

In southern Brazil where the Triassic comes in contact with the Permian, the former consists of massive red sandstones which rest unconformably on the Rochina limestone (Permian) but the extent of this unconformity is unknown.

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34. Kayser, E., loc. cit., p. 306.
35. Forbes, David, Quart. Jour. Geol. Soc. London, Vol. XVII, 1860, pp. 48–51.
36. Forbes, David, loc. cit. pp. 38–45.
37. Steinman, Gustav, Am. Nat., Vol. 25, 1891, p. 857.

The following section gives the general relations and more important subdivisions of the Triassic of Brazil:

Santa[38] Catharina System	Sao Bento series (Triassic)	Serra Geral eruptives.....	600 m.	900 m.
		Sao Bento sandstones, cliffs of red gray and cream colored sandstones......	200 m.	
		Rio do Rasto red beds with fossil Reptiles and fossil trees..................	100 m.	
	Passa Dois series.... (Permian)			223 m.
	Tubarao series.. (Permo-Carboniferous)			180 m.

The Rio do Rasto beds are composed of loosely consolidated red sands and conglomerates, while the Sao Bento beds consist of massive red, gray, and cream-colored sandstones which are sometimes conglomeratic and "often baked and vitrified by contact with the great sills of diabase which are so frequently intercalated between the massive layers as well as piled on top of the same.[39] The lower part of these beds (Sao Bento) are mostly red sandstone flags and the whole is apparently unfossiliferous. The hard vitrified rocks of the upper part of the series frequently form walls, towers, and buttes near the summits of the elevated peaks. The top of the section is made up of a great series of lava flows and the beds beneath are affected by numerous dikes and intrusive sheets.

The coal-bearing strata of southern Brazil is late Paleozoic, while that of Argentine and the Chilian Cordilleras belongs to the Rhaetic group and is partly covered by conformable marine deposits of lower Lias.[40]

The Triassic fossils of the Cordilleran region are of the same type as those found in California and western Canada, the leading fossil being *Pseudomonotis semicircularis* (?) Gratt.

Nearly all horizons of the Jurassic have been found to be fossiliferous and "the rich collections made in different parts of the Argentinian, Chilian and Peruvian Cordilleras have enabled us to determine that the succession of marine organic life during this period was quite the same on the Pacific slope as in Europe and East India, and there have existed very intimate faunistic relations between these regions."[41]

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38. White, I. C., Commissao de Estudos das Minas de Carvao de Pedra do Brazil. Relatio Final, 1908, p. 33.

39. White, I. C., loc. cit., p. 211.

40. Steinmann, Gustav, loc. cit., p. 857.

41. Steinmann, Gustav, loc. cit. p. 857.

Cretaceous. The Cretaceous deposits are wide-spread in South America and represent a notable encroachment of the sea upon the continent. "Marine Cretaceous fossils are found in nearly all parts of the Cordillera from South Patagonia to East Venezuela" and a rich marine fauna has also been discovered in the Cretaceous formations of east Brazil.[42]

"Certain of the characteristic Lower Cretaceous fossils of the North reappear in the South. The famous genus *Aucella*, widely distributed on the slopes of the North Pacific, has been recently mentioned by N. Ritin from Mexico; by White from Brazil; and I (Steinmann) know it also from the environs of Lima associated with Ammonites of the Neocomian of Europe."[43]

The undoubted marine deposits of the central part of South America disappear to the north and the south and are replaced by sandy deposits without marine fossils. "Probably a great part of the red sandstone formations which occur in Brazil, Venezuela, Bolivia, and in the north of the Argentine Republic, take the same place relative to the marine sediments as do the Atlantosaurus beds, the Trinity and Tuscaloosa formations in North America."[44]

The Ammonite-bearing beds of the Lower Cretaceous in Patagonia,[45] Peru, Venezuela[46] and Columbia[47], have been worked out in detail. Gerhardt refers these beds to the European horizons, Neocom (?), Barrémien, Aptien, and Albien. The beds consist of dark blue limestone interbedded with quartzite, white and red sandstones. In Patagonia these beds have a rather limited distribution and are overlain unconformably (?) by the Dinosaur beds.[48] These latter consist of red sandstones, conglomerates, with clays, marls and volcanic tuffs.

On the Pacific coast of south Chili glauconitic sandstones are found which contain a rich fauna of the uppermost Cretaceous. This is especially shown on the Island of Quiriquina. "Besides many Ammonites and Baculites, partly identical with those from south India, this fauna is characterized by the abundance of Gastropods of Tertiary type. The Cretaceous beds are covered conformably by a lignitic formation whose fauna does not contain the Cretaceous fossils; but startigraphically both formations are

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42. Steinmann. Gustav, loc. cit., p. 858.
43. Steinmann, Gustav, loc. cit., p. 858.
44. Steinmann, Gustav, loc. cit., p. 858.
45. Faru, Francois, Neues Jahrbuch fur Mineralogie, Geologie, und Palaeontologie, Vol. XXV (Beilage Band), 1908, pp. 601–647.
46. Gerhardt, K. Neues Jahrbuch für Mineralogie, Geologie, und Palaeontologie, Vol. XI (Beilage Band), 1897–8, pp. 65–117.
47. Gerhardt, K., loc. cit., pp. 118–208.
48. Roth, Santiago, Neues Jahrbuch fur Mineralogie, Geologie, und Palaeontologie, Vol. XXVI (Beilage Band), 1908, pp. 94–118.

intimately united."[49] (Compare this with the Chico-Tejon of northern California.) On the western side of the border of Chili and Peru, where the marine deposits of these formations predominate, only a very small part of the rocks are formed by limestones, clay slates, or sandstones. These appear, however, to be "interlaid between stratified masses of porphyritic, melaphyric and andesitic material, the entire thickness of which strata reaches several thousand meters."[50]

In the lower Amazon region the Cretaceous (?) rests unconformably on the Carboniferous. The Cretaceous consists of yellow and white clays with red iron stone and some impure limestone. The fauna of these beds shows a remarkably Tertiary aspect. It consists, for the most part, of Gastropods, Pelecypods, some Bryozoans, Corals and Echinoderms, as well as some probable Reptilian remains.

The plateau region of southern Pará is mostly covered by clay shales interstratified with red sandstones. The age of these rocks is believed to be middle and older Cretaceous, and perhaps in part even Triassic[51] or Permian.

CENOZOIC.

Tertiary. The Tertiary deposits of South America occur principally along the coastal margin especially of Brazil, Argentine, Chili and Peru. Also in the Amazon basin these beds cover a large area,[52] and again in southern Argentine the same is true.

In eastern Brazil the Tertiary strata consist of slightly consolidated sands and clays which are undisturbed and overlie the Cretaceous unconformably.[53] Fossiliferous Tertiary beds (Upper Miocene) occur in the vicinity of Coquimbo, Chili.[54] These Chilian Tertiary shell beds, however, are found but sparingly in Peru.[55] The Tertiary beds of southern Patagonia vary from æolian, swamp, and lacustrine deposits to sediments carrying a marine fauna, and these are often interbedded with each other. The maximum thickness is about 1500 feet.[56] Tertiary lava flows and intrusions of igneous rock are common throughout the Andes[57] and are not rare even in Patagonia.

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49. Steinmann, Gustav, loc. cit., p. 859.

50. Steinmann, Gustav, loc. cit., p. 859.

51. Katzer, Friedrich, Grundzuge der Geologie des unteren Amazonasgebietes, 1903, pp. 131–139.

52. Berghaus, Physikalischer Atlas, No. 14.

53. Hartt, C. F., Geol. and Phys. Geog. of Brazil, 1870, p. 557.

54. De Lapparent, A., Traité de Geologie, Vol. III, 1906, p. 1621.

55. Forbes, David, loc. cit., p. 9.

56. Hatcher, J. B., Am. Jour. Sci., 4th Ser., Vol. XI, 1900, p. 99.

57. Forbes, David, loc. cit., p. 12.

The deposits of borax, saltpetre, etc., in the Atacama desert and vicinity are of post-Tertiary age and are thought to have been formed by the deposition of the salts, contained in an inclosed portion of the sea, as the water evaporated.

Quaternary. Glacial drift (Pleistocene) occurs from Terra del Fuego northward at least to 41° S. latitude, while alpine glaciation occurs as far north as 9° S. latitude. "Besides the true glacial deposits and the æolian formations of loess and loam, there exists in South America, especially on the high plateau of Bolivia, lake deposits of great extent."[58]

Terraces and tuff deposits, analogous to those of the Great Basin region of North America, are well developed. Over the high lands of central Brazil and in Paraguay, river gravels and silts, similar to those of the Columbia formation, are also well developed, while the low plains and swamps are covered by alluvium.[59]

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58. Steinmann, Gustav, loc. cit., p. 860.
59. Evans, J. W., Quart. Jour. Geol. Soc. London, Vol. L. 1894, pp. 98, 99.

Chicago, 1909.

THE BLISTER RUST OF WHITE PINE (PERIDERMIUM STROBI KLEBAHN) FOUND IN OHIO.*

A. D. Selby.

Many are familiar with Circular 38, Bureau of Plant Industry, U. S. Department of Agriculture, issued in August, 1909, warning growers and importers of white pine seedlings that the blister rust of this species had been introduced into New York state and probably into Pennsylvania. This rust fungus, (Peridermium strobi Klebahn) has been found by rust specialists to be one stage of the blister rust of currants and gooseberries, (Cronartium ribicola Fisch. de Waldh.). The rust has long been of special interest in Europe, and particularly in Germany, because of its apparent preference to the American white pine, (Pinus strobus) as the host plant for the aecidial or peridermium stage. Now by one of these biological transferences, we have this particular rust fungus, heretofore unknown in America, brought back to the native home of the white pine. We have in this fact a situation which may be a serious drawback to the future successful culture of white pine in North America. Just how serious the drawback will finally prove cannot now be determined.

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* Presented at the Akron meeting of the Ohio Acad. of Sci., Nov. 25, 1910.

We know that there has recently been a marked development in interest in forest planting, and that among all the lumber trees thus far utilized for this purpose white pine has been a great favorite. So far as I know, no record exists of the discovery of the rust (Cronartium ribicolum) on currants and gooseberries in the United States, but the disease may be serious from this point of view as well. Through the kindly co-operation of the Department of Nursery and Orchard Inspection, the Department of Botany of the Experiment Station has received specimens of this rust upon white pine seedlings growing in beds at Painesville, Ohio. Mr. Evans, the Deputy Inspector, who discovered the diseased specimens, stated that there was only one found among the large number of seedlings. The specimen is preserved in the Station Laboratory at Wooster. And of course both the Department of Nursery and Orchard Inspection and the nursery people are striving to stamp out the disease so far as that shipment is concerned. The trees at Painesville were imported in the spring of 1909 from Levavasseur & Co., of Ussey, France. Subsequently, Mr. Evans discovered one or more diseased specimens on premises at Akron, Ohio. This lot of white pine was imported in the spring of 1908 from E. T. Dickinson, Chatenay, France.

Diseased Seedlings Probably of German Origin. We have from the observations of American visitors, notes that in the region of Ussey, and doubtless in that of Chatenay, there are no white pine grown. The French nurserymen had secured white pine seedlings more cheaply, as we had, by going to the German growers, and doubtless this is the explanation of the disease upon the seedlings imported from France. As stated in the Circular 38 before quoted, it was previously known that many German growers of white pine had sent diseased seedlings to the United States, and these had been distributed throughout much of New York and in parts of Pennsylvania.

EUPATORIUM ROTUNDIFOLIUM IN OHIO.

Robert F. Griggs.

The known range of Eupatorium rotundifolium L. would not lead one to expect to find it anywhere in Ohio. The writer was, however, fortunate enough to find it in an old field about a mile north of the discontinued postoffice at Cedar Grove a few miles east of South Bloomingville, Hocking Co. Here it occurs in great abundance though not seen in other parts of the Sugar Grove area. The plants were entirely similar to the northern representatives of the species preserved in the herbaria but like them differed somewhat from some of those collected in the southern portion of the range.

The range of the species as given in the manuals is: Rhode Island to Florida, Texas and Kentucky. The Gray Herbarium has specimens from New Jersey, Delaware, District of Columbia, Virginia, both coastal plain and mountain, North Carolina (Henderson Co. on the coastal plain and Biltmore in the mountains), Georgia, Florida, Mississippi, Texas ("prairies Rusk Co."), southwestern Arkansas, and Tennessee. In Pennsylvania it is reported by Porter from the coastal plain only but Shafer gives a record, unsupported by herbarium specimens, from Allegheny Co. I am indebted to Professor Fernald for the information that its range is now known to extend northward to the vicinity of Boston where it has recently been discovered though at the time of writing the record has not been published nor is the specimen available. The Ohio station extends the range known therefore about two hundred miles.

MEETINGS OF THE BIOLOGICAL CLUB.

Orton Hall, Nov. 7th, 1910.

The meeting was called to order by the President, Mr. W. C. Morse. The minutes of the preceding meeting were read and approved. Prof. J. C. Hambleton read the report of the Committee on Nominations of Officers for the ensuing year, which was as follows: Dr. A. Dachnowski for President, Mr. Clell L. Metcalf for Vice-President, B. W. Wells for Secretary-Treasurer. On motion by Prof. Landacre these persons were unanimously elected. Mr. W. J. Koster was elected a member of the Society.

After the short business session, Prof. Hambleton introduced Mr. Morse the retiring President, who gave an illustrated address on the Maxville limestone. The paper treated of the stratigraphy, correlation, economic geology, and paleontology of this

formation. Especial emphasis was placed on the distribution of the stratum, for this formation only appears in isolated areas. These isolated areas were formerly supposed to be the result of original deposition in separate basins, but the speaker was able to show that the isolation is due to the fact that the Maxville was originally a continuous deposit, which after being raised to a land surface was swept away in most places; the scattered remnants later being submerged to receive the Pottsville.

In the northern part of the area of exposures it was shown that the formation consisted of a massive lower half separated from a medium bedded upper half by a nodular shale zone.

The researches of the speaker resulted in increasing the fauna by 50% and the new forms clearly show the Maxville to have as its closest equivalent the Spergen Hill (Salem formation) fauna of Indiana. It was stated further that Ulrich has shown this Spergen Hill fauna to recur in the Ste. Genevieve and Tribune limestones and hence it is difficult to say with which of these the Maxville is equivalent. In the opinion of the speaker, after considering all available evidence, the nearest equivalent would be the upper member (Ohara) of the Ste. Genevieve limestone.

The society adjourned immediately after the address.

BERTRAM W. WELLS, *Secretary.*

ORTON HALL, December 5th, 1910.

The meeting was called to order by the President, Dr. Dachnowski. The minutes of the previous meeting were read and approved. The President then introduced Dr. Joseph A. Leighton who gave an interesting and stimulating address on "Some Contributions of Biology to Philosophy." Prof. Leighton pointed out the indebtedness of philosophy to biology showing in a number of instances how biological conceptions have invaded and modified philosophical thought. Succeeding the address an interesting discussion was engaged in by the faculty members present.

The latter part of the evening was taken up by reports of the Ohio Academy of Science meeting held at Akron during the Thanksgiving recess. Profs. Landacre, Osborn and Schaffner gave accounts of the papers presented and the work of the academy.

A short business meeting ensued. Mr. W. G. Stover, Mr. C. H. Goetz, Miss Rose Gormly and Miss Mary B. Linnell were elected to membership. The society then adjourned.

BERTRAM W. WELLS, *Secretary.*

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TABLE OF CONTENTS.

THE CLASSIFICATION OF PLANTS, VI.*

JOHN H. SCHAFFNER.

In a previous paper of this series, the writer defined the classes of plants† and also divided the Monocotyls and Dicotyls into ten subclasses. In the arrangement given only a moderate departure was made from the Engler and Prantl scheme, although it was recognized that present morphological knowledge would warrant greater changes. Having become accustomed to thinking along phyletic lines of classification in the meantime, through rather extensive investigations, the writer is now prepared to take a more radical position in the direction of a rational system. The time has come when present accepted facts and theories of morphology and evolutionary doctrines should be reflected in plant classification. Bessey's "A Synopsis of Plant Phyla" published in 1907 is a most important contribution to the subject of taxonomy and can readily be taken as a basis for further studies. Some of the groupings given below have been taken from the "Synopsis," while a considerable part had been worked out independently before a copy of that work was received. It was, therefore, a source of considerable satisfaction to find that the writer's own results were essentially the same as Bessey's. For if one breaks away from past "authority," the application of modern ideas to the problem of relationships should lead to more or less definite results. In so far as they represent essentially similar groups, the names adopted by Bessey have also been applied to the present classification; for the "name of a group is only a name and not a definition." The names not agreeing with Bessey's

* Contribution from the Botanical Laboratory of Ohio State University, 60.
† The Classification of Plants, IV. Ohio Nat. 9 : 446–455, 1909.

have been adapted from older classifications. In this connection it might be stated that the Bentham and Hooker scheme of classification contains certain features which should not be thrown overboard bodily without due consideration.

As stated in a previous article of this series, all possible characters and peculiarities should be considered in segregating groups. Gross and microscopic, and external and internal morphology, as well as embryology, physiology, and life cycle are important and must be taken into account if contradictions in supposed lines of descent are to be avoided. But when the groups have thus been established, one or at most, a very few definite characters in combination should give an exclusive definition.

It will be evident to anyone, who has considered the subject in some detail, that the groups of monocotyls and dicotyls cannot be segregated on the basis of the flower alone, although the flower is perhaps the most important structure in the Anthophyta to indicate relationship. There may be apocarpous and syncarpous, apetalous and choripetalous, monosporangiate and bisporangiate, and numerous other diverse developments in very closely related groups. From an evolutionary point of view, the starting-point of floral development must be sought among the homosporous and heterosporous Pteridophyta. The flower of the higher plants then seems to have come from a definite, bisporangiate strobilus or cone. This is especially apparent in the angiosperms where the monosporangiate flower usually shows vestiges of one or the other set of sporophylls. These vestiges in the angiosperm flower are very conclusive, and in deciding whether a given structure is primitive or specialized their recognition becomes of primary importance.

The general progression is then about as follows:

1. Indefinite bands of sporophylls with further growth of the axis.
2. Definite bisporangiate strobili.
3. Development of a perianth in the Anthophyta.
4. Reduction of the floral organs to definite cycles and numbers.
5. Extreme modifications in the typical floral organs and also in the parts immediately surrounding.

As often pointed out the evolutionary lines in the flower are then:

1. From spiral to cyclic and to reduced cycles, in the monocotyls mostly trimerous, occasionally tetramerous or dimerous, and in the dicotyls mostly pentamerous, but occasionally tetramerous, trimerous or dimerous.
2. From pentacyclic to tetracyclic or still fewer sets.
3. From hypogynous to perigynous and epigynous conditions.
4. From parts free to parts united, as from apocarpy to syncarpy.

5. From choripetalous to sympetalous, apetalous or naked flowers.

6. From spiral to actinomorphic flowers, and further to isobilateral, unsymmetrical, or zygomorphic types.

7. From bisporangiate to monosporangiate and further from monecious to diecious flowers.

8. From types with all the organs normal to those that show vestigal parts.

These developments are repeated again and again. Certain of these specializations show themselves even in primitive groups. In many cases no relation with the environment is evident, but advancing tendencies apparently originate in the internal constitution of the plant itself. Thus we are led to recognize tendencies which may or may not come to expression in the diverse species of a natural group. The whole phylogenetic development bears a close resemblance to the ontogenetic expression of hereditary characters in the individual.

The development of the inflorescence is equally interesting with that of the flower itself. In the primitive groups a single flower terminates a main vegetative branch and from this condition appear all gradations of reduction and clustering through racemes, corymbs, and panicles to spikes, spadixes, catkins, heads, and disks, and their various modifications.

In general then, the process of segregation, classification and arrangement should proceed on the following basis:

1. Development of the floral organs.
2. Specialization and degeneration of the floral parts.
3. Specialization and degeneration of the vegetative parts.

The segregation must be fundamentally phyletic and should follow a recognition of the gaps produced by variation, mutation, and the destruction of intermediate types, while the arrangement in series should follow the evolutionary progression as indicated by comparative morphology and complexity of life cycle, together with the presence of vestigial parts. Vestigial organs are of the highest importance in any classification of the angiosperms because of their common occurrence. It is necessary, therefore, to be able to distinguish vestigial organs or vestiges from nascent organs or primordia. Paleontological evidence would here be of paramount importance but satisfactory fossil flowers are too rare for our purpose.

Before taking up the special question of the relationships in the Anthophyta a word may be said in regard to the importance of synopses. The synopsis is commonly confused with a key for identification. A synopsis should show the supposed phyletic relationship; a key should be the easiest means for ascertaining a name whether of group or species. In most cases the synopsis does not make a satisfactory, working key. The genera of

Araceae of the northeastern United States are treated below for illustration. This synopsis is supposed to show both the natural relationships and the orderly arrangement, in series, of groups of lower and higher value. The key is simply a device for the easy recognition of the genera. The essential mark of a good key is that it makes use of such characters only as are present at a certain season of the year or a certain period of the life history.

SYNOPSIS.

I. Flowers bisporangiate; plants without or with lactiferous cells.
  1. Without lactiferous cells; with a perianth . . . . . POTHATAE
    a. Without a typical spathe . . . . 1. *Acorus*
  2. With lactiferous cells; with or without a perianth CALLATAE
    a. Without a typical spathe; with a perianth. . . .2. *Orontium*
    b. With an open spathe; without a perianth; spadix elongated . . . . .3. *Calla*
    c. With an enveloping spathe; with a perianth; spadix globose . . . . .4. *Spathyema*

II. Flowers monosporangiate; plants with lactiferous cells; without a perianth.
  1. Spadix covered to the tip with flowers . . . . PHILODENDRATAE
    a. Flowers monecious; leaves simple. . . . . . .5. *Peltandra*
  2. Spadix with a sterile projection at the tip . . . . .ARATAE
    a. Flowers monecious or diecious; leaves compound.
6. *Arisaema*

KEY.

1. Inflorescence without an obvious spathe; flowers bisporangiate, with a perianth. 2.
1. Inflorescence with a large, expanded spathe. 3.
2. Spadix apparently lateral; scape 3-angled and grooved. *Acorus*.
2. Spadix terminal; scape cylindrical. *Orontium*.
3. Leaves compound; spadix with a prominent sterile projection at the tip. *Arisaema*.
3. Leaves simple; spadix usually without a sterile projection at the tip. 4.
4. Flowers monecious, on an elongated spadix; leaves prominently sagitate with rather distinct points. *Peltandra*.
4. Flowers bisporangiate, on an oval or globose spadix; leaves cordate or only slightly sagitate. 5.
5. Spathe open, with a slender point; spadix ovoid or somewhat elongated. *Calla*.
5. Spathe enclosing the globose spadix; not with a slender point. *Spathyema*

At present we do not possess the necessary morphological details to make a final classification, yet the broad outlines of a natural arrangement can be laid down with a fair degree of certainty. When several parallel lines are to be grouped, one can, of course, use his individual judgment, the better plan probably being to follow expediency. If the methods and principles employed are correct there should not be much change in the general scheme, in the future, except in matters of detail. The larger problem of the correct limits of families and orders cannot, of course, be considered at present. It must be recognized, however, that some of the families, like Saxifragaceae, as formerly delimited, are mere waste-baskets to receive odds and ends which

may belong elsewhere. It is believed that the segregation into sub-classes, as given below, is essentailly correct and represents phyletic developments. In the older arrangements the treatment of the series is often very inconsistent, in some cases proceeding from the primitive to the specialized, in others from the most highly specialized to the most primitive, as in the case of the grass family. The arrangement must be inverted beginning with the primitive bamboos and ending with such extremely specialized genera as Indian corn.

The sub-classes at present recognized by the writer are as follows:

- MONOCOTYLAE:
  - Helobiae.
  - Spadiciflorae.
  - Glumiflorae.
  - Liliiflorae.
- DICOTYLAE:
  - Thalamiflorae.
  - Centrospermae.
  - Calyciflorae.
  - Amentiferae.
  - Myrtiflorae.
  - Heteromerae.
  - Tubiflorae.
  - Inferae.

There can be little question but that the Helobiae represent the lowest monocotyls and the Thalamiflorae the lowest dicotyls. Any comparative morphology based on phyletic ideas must come to this conclusion. The lower types of these two subclasses are about on a level. There is little point, therefore, to the discussions as to whether monocotyls or dicotyls are the higher group. Since the highest dicotyls go far beyond the highest monocotyls in floral specialization, it is more convenient to place the monocotyls first in the list, even though the gametophytes of their highest members, the Orchidaceae, probably represent the most extreme reduction and specialization. The classification of the vascular plants should be based primarily upon the sporophyte.

Finally, it should be clear that generalizations as to primitive conditions and evolutions can not be based upon such extremely specialized forms as Welwitschia (Tumboa), Piperaceae, Casuarina, and other peculiar groups. The gametophytes and the minute morphology have undergone specialization as well as the more exposed parts.

A general representation of the supposed relationship is given in Figure 1. The Helobiae begin with the Alismaceae and related forms and end with the Vallisneriaceae which are highly special-

ized, monosporangiate, and epigynous. The Nymphaeaceae are an intermediate lateral branch of the Helobiae. The morphological evidence for this view is overwhelming. There is no reason for separating the Hydrocharitales from the Helobiae as is frequently done, for their morphology and cytology show the relationship conclusively.

Whether the Spadiciflorae represent more than one subclass may be a question, but they nevertheless show a closer relationship among themselves than to either the Helobiae or Liliiflorae.

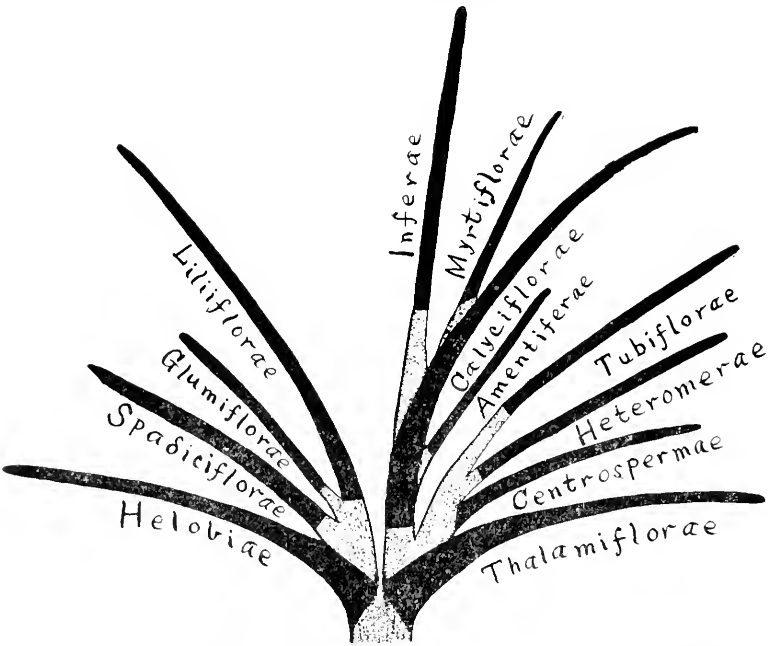


Fig. 1. Diagram of the Subclasses of Monocotylæ and Dicotylae.

The Glumiflorae may be an offshoot from either the Spadiciflorae or Liliiflorae. They have thus been placed in a neutral position, in the diagram, between the two. They represent extreme specializations as indicated by the numerous vestigial structures.

The main families of the Liliiflorae make a natural group extending from the Liliaceae to the Orchidaceae. The Liliales may need some further rearrangement from that indicated below, but it is not considered advisable to separate them into two orders as is frequently done.

In the Dicotylae the problem of classification is, of course, much more difficult than in the Monocotylae, because of the far

greater numbers involved, and the complexity of structure. This is especially true of the choripetalous families, where it is almost impossible for the mind to grasp the enormous number of types to be considered.

The Thalamiflorae are the lowest dicotyls. The first order, the Ranales, constitute a parallel group to the hypogynous Helobiae. The Ranales are closely followed by the Sarraceniales, Brassicales, and the lower Gerianales and Malvales.

The Centrospermae are a small branch having its origin in the Thalamiflorae. Its lowest family, the Caryophyllaceae, indicates the relationship while the higher forms are greatly specialized, passing over into reduced apetalous and naked flowers with high development of the inflorescence.

The Calyciflorae represent another great, fundamental branch of choripetalous dicotyls arising from near the Ranales, but somewhat more specialized. The lower genera of Rosaceae show marked resemblances to some Ranunculaceae. The other families placed in this subclass are fairly certain and there may be families and genera at present associated with other subclasses that properly belong here.

The Amentiferae are a small but important group whose realtionship may be traced from the lower Calyciflorae through the Hamamelidaceae, Platanaceae, Ulmaceae, Moraceae, etc., up to the Salicaceae. A number of families now included are uncertain. One of the structures of the group is the highly specialized flower cluster, the catkin, and there are other significant features as chalazogamy besides various peculiarities of buds, twigs and leaves.

The Myrtiflorae are an epigynous branch, mostly of choripetalous dicotyls, probably derived from the Calyciflorae, from the vicinity of the Saxifragales. Some of the families may be excluded in the future but the main mass represents a distinct type of floral development and appears to be phylogenetically related, excepting, perhaps the cactales which may even belong to the Centrospermae.

The Heteromerae appear to have come from near the same region as the Centrospermae. The strong resemblance of certain Caryophyllaceae to Primulaceae is very suggestive and gives support to this view. The Heteromerae also show their primitive character by frequent choripetaly and other peculiarities.

From the lower Heteromerae it is but a step to the Tubiflorae, the lowest forms of which are represented by the Convolvulaceae and Polemoniaceae. The families of the Tubiflorae are for the most part quite certain, except perhaps the Plantaginaceae.

The last and highest subclass of Dicotylae, the Inferae, appears to be an offshoot from the lower Calyciflorae, the line leading almost directly from the Saxifragales to the Umbellales, Rubiales, Campanulales, and Compositales.

The application of the preceding scheme of classification to the families of Anthophyta represented in the northeastern United States will give the following arrangement:

Phylum, ANTHOPHYTA.

Class, MONOCOTYLAE.

Subclass I. HELOBIAE.

1. **Alismales**—Alismaceae, Scheuchzeriaceae, Potamogetonaceae Naiadaceae.
2. **Nymphaeales**—Nymphaeaceae (Nelumbonatae, Nymphaeatae).
3. **Hydrocharitales**—Vallisneriaceae.

Subclass II. SPADICIFLORAE.

4. **Pandanales**—Sparganiaceae, Typhaceae.
5. **Arales**—Araceae (Pothatae, Callatae, Philodendratae, Aratae), Lemnaceae.

Subclass III. GLUMIFLORAE.

6. **Graminales**—Cyperaceae (Scirpatae, Rhyncosporatae, Caricatae), Graminaceae (Poacatae, Panicatae).

Subclass IV. LILIIFLORAE.

7. **Liliales**—Liliaceae (Melanthatae, Liliatae, Convallariatae), Smilaceae, Juncaceae, Commelinaceae, Pontederiaceae, Mayacaceae, Xyridaceae, Eriocaulaceae.
8. **Iridales**—Amaryllidaceae, Haemodoraceae, Iridaceae, Dioscoreaceae, Bromeliaceae.
9. **Scitaminales**—Marantaceae.
10. **Orchidales**—Burmanniaceae, Orchidaceae (Cypripediatae, Orchidatae).

Class, DICOTYLAE.

Subclass I. THALAMIFLORAE.

1. **Ranales**—Magnoliaceae, Anonaceae, Ranunculaceae, Ceratophyllaceae, Berberidaceae, Menispermaceae, Lauraceae.
2. **Sarraceniales**—Sarraceniaceae, Droseraceae.
3. **Brassicales**—Papaveraceae, Fumariaceae, Brassicaceae, Capparidaceae, Resedaceae?
4. **Geraniales**—Geraniaceae, Oxalidaceae, Balsaminaceae, Tropaeolaceae, Linaceae, Zygophyllaceae, Rutaceae, Simarubaceae, Polygalaceae, Euphorbiaceae, Callitrichaceae.
5. **Malvales**—Malvaceae, Tiliaceae.
6. **Guttiferales**—Theaceae, Hypericaceae, Cistaceae, Violaceae, Passifloraceae.

Subclass II. CENTROSPERMAE.

7. **Caryophyllales**—Caryophyllaceae, Elatinaceae, Aizoaceae, Portulacaceae, Nyctaginaceae, Phytolaccaceae.
8. **Chenopodiales**—Illecebraceae, Amaranthaceae, Chenopodiaceae.
9. **Polygonales**—Polygonaceae.
10. **Piperales**—Saururaceae.

Subclass III. CALYCIFLORAE.

11. **Rosales**—Rosaceae (Rosatae, Pomatae, Drupatae), Calycanthaceae, Fabaceae (Mimosatae, Cassiatae, Papilionatae).
12. **Saxifragales**—Crassulaceae (Crassulatae, Penthoratae), Podostemaceae, Parnassiaceae, Saxifragaceae, Iteaceae.
13. **Celastrales**—Rhamnaceae, Vitaceae, Celastraceae, Buxaceae, Ilicaceae, Cyrillaceae, Staphyleaceae, Thymeleaceae, Elaeagnaceae.
14. **Sapindales**—Sapindaceae, Hippocastanaceae, Aceraceae, Empetraceae, Limnanthaceae, Anacardiaceae.

Subclass IV. AMENTIFERAE.

15. **Platanales**—Hamamelidaceae, Platanaceae.
16. **Urticales**—Ulmaceae, Moraceae (Moratae, Cannabatae), Urticaceae.
17. **Fagales** — Fagaceae, Betulaceae, Juglandaceae, Leitneriaceae, Myricaceae.
18. **Salicales**—Salicaceae.

Subclass V. MYRTIFLORAE.

19. **Cactales**—Cactaceae.
20. **Myrtales**—Lythraceae? Hydrangeaceae, Grossulariaceae, Melastomaceae, Onagraceae, Trapaceae, Haloragidaceae, Hippuridaceae.
21. **Loasales**—Loasaceae, Cucurbitaceae.
22. **Aristolochiales**—Aristolochiaceae.
23. **Santalales**—Santalaceae, Loranthaceae.

Subclass VI. HETEROMERAE.

24. **Primulales**—Primulaceae, Plumbaginaceae.
25. **Ericales**—Clethraceae, Pyrolaceae, Monotropaceae, Diapensiaceae, Ericaceae, Vacciniaceae.
26. **Ebenales**—Sapotaceae, Ebenaceae, Symplocaceae, Styracaceae.

Subclass VII. Tubiflorae.

27. **Polemoniales**—Convolvulaceae, Cuscutaceae, Polemoniaceae, Hydrophyllaceae.
28. **Gentianales**—Oleaceae, Loganiaceae, Gentianaceae, Menyanthaceae, Apocynaceae, Ascelpiadaceae.
29. **Scrophulariales**—Solanaceae, Scrophulariaceae, Orobanchaceae, Bignoniaceae, Martyniaceae, Lentibulariaceae, Acanthaceae.
30. **Lamiales**—Boraginaceae, Verbenaceae, Lamiaceae, Phrymaceae.
31. **Plantaginales**—Plantaginaceae.

Subclass VIII. Inferae.

32. **Umbellales**—Araliaceae, Ammiaceae, Cornaceae.
33. **Rubiales**—Rubiaceae, Adoxaceae, Caprifoliaceae, Valerianaceae.
34. **Campanulales**—Campanulaceae (Campanulatae, Lobeliatae).
35. **Compositales**—Dipsacaceae, Ambrosiaceae, Helianthaceae, Cichoriaceae.

A Collection of Atlases. There recently came to the library of Ohio State University a two volume work of 1600 pages, giving titles, for, and in some cases short notes about, the atlases now in the library of Congress at Washington There are over 3,400 of these atlases covering a very wide range of data. It would seem that nearly everything could be reduced to a map. There are atlases astronomical, cartographical, commercial, ecclesiastical, geological, historical, ethnographical, physical and political; business, real estate and military atlases; general atlases, atlases of discovery, of exploration, of boundaries, of oceans, rivers, harbors, crops, and many resources; atlases of population, diseases, and many vital statistics.

Twelve pages and ninety titles are devoted to the atlases of Ohio, beginning with Walling's Atlas of Ohio in 1868, followed by the Geological Survey Atlas, and Hardesty's historical and military encyclopedias each with an extensive atlas. Then come most of the counties with atlases and plat-books, followed by a series of city atlases.

For New York State there are 137 atlases, including 28 devoted to the city alone.

Almost any scientist or philosopher could find basal material for research, charted here and ready for comparative studies.

G. D. Hubbard.

THE STRATIOMYIDAE OF CEDAR POINT, SANDUSKY.

(Order Diptera)

BENTLEY B. FULTON.

A shallow, weedy body of quiet water with a low muddy or sandy shore, is the ideal breeding place for most Stratiomyidae. These conditions are found at Cedar Point. The shore of Sandusky Bay along the point is low and sandy and in most places covered with a layer of mud and debris washed up by the waves. Along the shore there are many patches of swamp land. At the eastern end of the bay there is a swamp covering several square miles, through which run many winding flood channels; the largest of these is called Black Channel. The bottom of the bay has a thick deposit of mud and supports a luxuriant growth of submerged plants, while on the surface in many places are thick mats of algae and floating plants. All these conditions are favorable and most of the species found were very common. Since no collecting has been done at Cedar Point before the middle of June, it is probable that there are a number of early forms which have not been taken.

The family Stratiomyidae is a rather large one, having about one thousand described species, of which about two hundred are found in North America. They are bare or thinly pilose flies with flattened abdomen and often having bright yellow or green markings which give them the name of Soldier Flies. The squamae are small or vestigial, tibiae without spurs and the antennae are three-jointed, the third joint being composed of several annulations and often bearing a terminal arista. The wings are clear or smoky and are held along the abdomen when at rest. Species of this family may be easily recognized by the venation of the wing; the longitudinal veins being more or less crowded along the costal margin, while the posterior veins are often weak or vestigial. The discal cell is usually small and oval or irregularly six-sided.

C. A. Hart in his "Entomology of the Illinois River" has given many interesting observations on the habits of Stratiomyidae. He found the females of Odontomyia cincta and O. vertebrata ovipositing on reeds, stakes and dead branches in the water. The larvae of Stratiomyia and Odontomyia are elongate and flattened, rather large, and of an opaque greenish, brown, or gray color obscurely striped. The former prefer the low shores and are found crawling over the mud or living in the plant debris, while the latter live in the water. The pupa is formed in one end of the larval skin, which becomes inflated and floats on the water. The imago emerges through a median slit connecting transverse slits in the second and fourth segments.

The adults are found about flowers or resting on plants near the water, and may be collected by sweeping with the net. The flowers of milkweed (*Asclepias*) are very attractive to many kinds of flies including Stratiomyidae, Syrphidae, Tabanidae, Muscidae, Tachinidae, Sarcophagidae, Dexidae and Conopidae. Two species of milkweeds are found at Cedar Point, *Asclepias syriaca* L. and *A. incarnata* L. Along the point in the vicinity of Black Channel there is an abundant growth of the former, and at times the clusters of flowers are nearly covered with flies and many more are buzzing around them. The flowers of this genus have a remarkable adaptation for cross pollination by insects. As the insect crawls over the flower its claws catch in V-shaped fissures between the nectariferous hoods and are guided along a slit to a notched disk which clings to the foot. To this disk are fastened two flat, spatulate pollen masses or pollinia, which are pulled out by the insect and carried to other flowers. A few of the small bees and many of the flies are unable to pull out some of the pollinia and are thus entrapped. This facilitates matters for the collector, for they can then be picked off with the fingers and put into the cyanide bottle. Some of the specimens had as many as ten pairs of pollinia clinging to their feet. The species of Odontomyia are more often entrapped than Stratiomyia, which are larger. Those that are not entrapped may often be caught by clapping them into the bottle with the cork. The swamp milkweed (*A. incarnata* L.) is found at the waters edge or at the edge of the cat-tail zone. It is not so much frequented by Stratiomyidae as by other insects, and on many of the flower clusters there are one or two ambush bugs (*Phymata erosa* L.), which probably devour many of the entrapped flies.

The yellow pond lily (*Nymphaea advena* Ait.) is another flower on which a number of flies can be found. They must be approached carefully in a boat, for some of the larger flies will fly out if the water is much disturbed. On coming near enough one can slip the hand under the flower and close it up. The whole flower can then be broken off and put in the cyanide bottle for a short time, after which it should be removed and the flies sorted out. Other common plants which are very attractive to flies and other insects are the blue vervain (*Verbena hastata* L.), the swamp rose mallow (*Hibiscus Moschentos* L.) and the pickerel-weed (*Pontederia cordata* L.) Good collecting can be done by sweeping among the swamp grasses. At times the end of the net, with whatever it may contain, can be put in the cyanide bottle for about a minute and then removed and the desirable specimens taken out.

The following species have been taken:

Odontomyia—
- cincta Olivier.
- hydroleonoides Johnson.
- virgo Wied.
- vertebrata Say.
- nigerrima Loew.

Stratiomyia—
- badia Walker.
- lativentris Loew.
- meigenii Wied.
- normula Loew.
- discalis Loew.

Geosargus elegans Loew.
Pachygaster pulcher Loew.
Nothomyia viridis Hine.

The first three species of Odontomyia were very common both on land and water, while O. vertebrata and O. nigerrim seem to be rare, only one specimen of each having been taken. The species of Stratiomyia were found on land and were commonest in the vicinity of Black Channel.

A NEW SPECIES OF NOTHOMYIA.

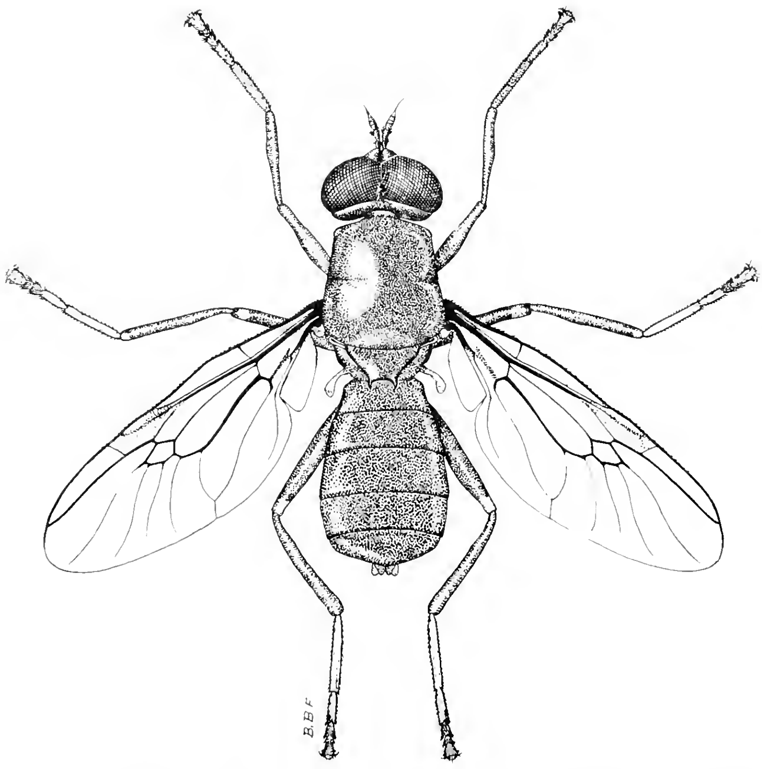
JAS. S. HINE.

The genus Nothomyia is one of the little known genera of Diptera so far as records show. It was described by Loew in *Diptera Americae Septentrionalis*, Centuria VIII, 4, 1869, and so far as I have observed there are no references to it since except in check lists and manuals. Two Cuban species were described at the time and Loew expressed the opinion that Oxycera metallica Weidemann, from St. Thomas should be included.

Members of the genus have the abdomen five segmented, scutellum with two marginal spines, third antennal segment with a terminal arista, eyes contiguous in the male and separated in the female. Wings with four posterior veins, three of which arise from the discal cell and the fourth from the second basal. Third vein without an anterior branch. Nothomyia scutellata Loew from Cuba is the type species.

Nothomyia viridis n. sp. Length five millimeters Body shining green above and clothed rather sparsely with soft white hair. Front in the female rather narrow above, gradually widened downward, produced below so that the antennae are at the tip of a distinct prominence, front of male similar but divided by the eyes. Antenna with three distinct segments, first segment about equal to the second, third segment composed of annulations and

with a terminal arista which is longer than the remainder of the antenna, three small ocelli arranged in the form of a triangle near the vertex, face on the under side of the head, only slightly oblique and clothed with rather long white hairs, proboscis dark yellowish, short and fleshy. Thorax shining green above and on parts of the sides, black beneath, front legs black throughout, other femora and tibiae and last three segments of tarsi black, first two segments of tarsi white or very pale yellow. In most specimens all the femora are dark yellow apically and the same color may be present on the inner sides of the apices of the tibiae. Wings hyaline, stigma pale yellow. Knob of Halteres yellow. Abdomen green above, black beneath, clothed everywhere with white hair.



The male type and fourteen other specimens taken on Cedar Point, Sandusky, in July. One male taken by B. B. Fulton. Specimens procured while resting on leaves of various species of plants.

This species varies some in size and in the color of the legs, but on the whole the specimens at hand are fairly uniform.

AN OHIO STATION FOR PHACELIA DUBIA.

ROBERT F. GRIGGS.

Phacelia dubia (L) Small has been included in the Flora of Ohio since Newberry's Catalog which reported it on the authority of Sullivant. No other collector, however, has since found it and the state herbarium has long maintained an empty cover for it. The writer was therefore glad to discover it growing on the ridge a mile west of Clark's Crossing in Fairfield County and later to find Sullivant's specimen in the Gray Herbarium at Harvard labeled simply "Lancaster, Ohio, Sullivant" in Asa Gray's handwriting.

The station is a narrow ridge of Black Hand Sandstone from which all of the overlying rock of the Logan formation has been removed leaving it bare or clothed with a thin soil. It bears a growth of fair sized trees mostly pine and rock or black oak and numerous rather xerophytic herbs of which the most typical is the "Wild Sweet Pea," Tephrosia virginiana. In view of this habitat the manual notation "Shaded Banks" is rather misleading. Similar habitats are to be found occasionally throughout the Sugar Grove region but the writer has seen the plant nowhere else except at "Kettle Hills," a mile or two north of the present station. Sullivant probably obtained his plant from one of these stations, and since no one else has found it, it may be doubted if it occurs elsewhere in the state.

This supposition is supported by the general range of the species for it seems to be confined to the Allegheny region from New York and Ohio southward, although it is given in the manuals as "New York to Kansas and southward." Through the whole of this range it is rare and local being known from only a few stations in each state. In New York it is known only near Jamesville where it was discovered a few years ago by Mrs. L. L. Goodrich growing on limestone rock. In Pennsylvania it is reported by Porter from Lancaster and Perry Counties. In Maryland specimens from the Great Falls of the Potomac are marked "rare." In Tennessee Gattinger knew it only from the vicinity of Nashville and in Alabama Mohr cites only two counties with the notation "Local and infrequent."

The record from Kansas is based on a specimen collected by Hitchcock in Cherokee County in the extreme southeastern corner of the state. This is, however, not Phacelia dubia but Phacelia hirsuta Nutt. and corresponds almost exactly with Nuttall's plant which came from Arkansas. The writer has, however, made a careful study of the plants and the descriptions and has satisfied himself that the two are not specifically separable but that hirsuta is simply a more hairy subspecies. It occurs with the species

about Nashville, Tennessee, also in Giles County, Virginia, and on the summit of Stone Mountain, Georgia, where it has been repeatedly collected. But its main range seems to lie to the westward of the species, from Missouri (Potosi) to Kansas (Cherokee County) and southward into Texas.

EUPATORIUM AROMATICUM IN OHIO.

Robert F. Griggs.

So far as the writer is aware Eupatorium aromaticum L. has never been suspected of being a member of the Ohio Flora. Great, therefore, was the writer's joy in finding it growing abundantly along the roadside in the valley of Queer Creek about three miles east of South Bloomingville, Hocking County, September 7, 1910. The plants were at once recognized as entirely distinct from the common E. ageratoides with which the species sometimes intergrades and on comparison with herbarium specimens proved to be perfectly typical representatives of E. aromaticum.

The general distribution of the species as given by the manuals, Britton and Gray, is "Copses, etc., Massachusetts to Florida near the coast." Reference to herbarium specimens and local floras shows however, a considerably wider range. In the Gray herbarium at Harvard are specimens from Massachusetts, Rhode Island, District of Columbia, Virginia, (Norfolk Co. on the coast and Bedford and Craig Counties in the mountains). North and South Carolina, Georgia, Florida, Alabama, and Louisiana, (Jacksonville). In addition it is reported from the Tullahoma flats near Knoxville, Tenn., by Gattinger and from Jackson County in southern Illinois by Patterson and from the vicinity of Pittsburg by Shafer, though in this case the reference is unsupported by a herbarium specimen. Even with these additions the present station is about two hundred miles from the edge of its range as previously known. Whether or not it occurs generally over the area indicated can not be determined from the data at hand but in any case the range should be revised to include the localities given above.

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TABLE OF CONTENTS.

THE VASCULAR PLANTS OF THE CRANBERRY BOG IN BUCKEYE LAKE.

FREDA DETMERS.

A floristic survey is being made of the bogs and swamps in Ohio; and as soon as it is complete the list of plants will be published. This present list includes the Vascular plants of the Cranberry Bog or Cranberry Island in Buckeye Lake. The list of Thallophyta and Bryophyta is not yet complete and will be published later.

Osmunda regalis L.
" cinnamomea L.
Dryopteris thelypteris (L.) A Gr.
" cristata (L.) A Gr.
" spinulosa (Retz.) Kuntze.
Typha latifolia L.
" angustifolia L.
Potamogeton natans L.
" zosteraefolius Schum.
" pusillus L.
" pectinatus L.
" sp.
Scheuchzeria palustris L.
Sagittaria latifolia Willd.
Echinochloa walteri (Pursh.) Nash.
Panicum capillare L.
Homalocenchrus oryzoides (L.)Poll.
Muhlenbergia racemosa (Mx.) B. S. P.
Calamagrostis canadensis (Michx.) Beauv.
Eragrostis hypnoides (Lam.)B.S.P.
Panicularia nervata (Willd.) Kuntze.
Cyperus erythrorhizos Muhl.
" strigosus L.
Dulichium arundinaceum (L.)Britt.
Eleocharis obtusa Schultes.
" palustris (L.) R. & S.
" palustris glaucescens (Willd.) A. Gr.
" acicularis (L.) R. & S.
" tenuis (Willd.) Schultes.
Scirpus lacustris L.
" fluviatilis (Torr.) A. Gr.
" cyperinus (L.) Kunth.
Eryophorum virginicum L.
Rynchospora alba (L.) Vahl.
Carex alata Torr.
" scirpoides Schkuhr.
" retroflexa Muhl.
" vulpinoidea Michx.
" decomposita Muhl.
" diandra Schrank.
" diandra ramosa (Boott.) Fernald.
" stipata Muhl.
" aquatilis Wahl.
" stricta Lam.
" leptalea Wahl.
" limosa L.
" filiformis L.
" pseudo-cyperus L.
" comosa Boott.

Peltandra virginica (L.) Kunth.
Spirodela polyrhiza (L.) Schleid.
Lemna trisulca L.
" minor L.
Wolffia columbiana Karst.
Wolffiella floridana (J. D. Sm.) Thomp.
Juncus effusus L.
" brachycephalus (Engelm.) Buch.
" canadensis J. Gay.
Habenaria clavellata (Mx.) Spreng.
" lacera (Michx.) R. Br.
" leucophaea (Nutt.) Gray
Pogonia ophioglossoides (L.) Ker.
Arethusa bulbosa L.
Limodorum tuberosum L.
Gyrostachys cernua (L.) Kuntze.
Salix pedicillaris Pursh. (S. myrtilloides (Gray man. Ed. 6.)
" discolor Muhl.
" sericea Marsh.
Alnus rugosa (Du Roi) Spreng.
Quercus palustris Du Roi.
" imbricaria Michx.
Adicea pumila (L.) Gray.
Boehmeria cylindrica (L.) Sw.
Rumex verticillatus L.
" brittanica L.
Polygonum emersum (Michx.) Britt.
" punctatum Ell.
" arifolium L.
Acnida tamariscina (Nutt.) Wood.
Nymphaea advena Ait.
Castalia odorata (Dryand) Woodv. and Wood.
Nelumbo lutea (Willd.) Pers.
Ceratophyllum demersum L.
Batrachium trichophyllum (Chaix.) Bossch.
Roripa palustris (L.) Bess.
" americana (A. Gr.) Britt.
Cardamine bulbosa (Schreb.)B.S.P.
Drosera rotundifolia L.
Rubus nigrobaccus Bailey.
Comarum palustre L.
Geum canadense Jacq.
" virginianum L.
Agrimonia parviflora Soland.
Rosa carolina L.
Aronia arbutifolia (L.) Medic.
" atropurpurea Britt.
" nigra (Willd.) Britt.
Prunus virginiana L.
Lathyrus palustris L. var. linearifolius Ser.
Apios apios (L.) MacM.
Rhus vernix L.
Ilex verticillata (L.) A. Gr.
Acer rubrum L.
Impatiens biflora Walt.
Hibiscus moscheutos L.
Triadenum virginicum (L.) Raf.
Viola blanda Willd.
Decodon verticillatus (L.) Ell.
Epilobium strictum Muhl.
Onagra biennis (L.) Scop.
Cicuta bulbifera L.
Sium cicutaefolium Schrank.
Cornus stolonifera Michx.
Gaylussacia resinosa T. and G.
Oxycoccus macrocarpus (Ait.)Pers.
Bartonia virginica (L.) B. S. P.
Menyanthus trifoliata L.
Asclepias incarnata L.
Convolvulus sepium L.
Cuscuta gronovii Willd.
Teucrium canadense L.
Scutellaria lateriflora L.
Lycopus virginicus L.
Mentha canadensis L.
Solanum dulcamara L.
Chelone glabra L.
Gerardia paupercula (Gr.) Britt.
Utricularia vulgaris L.
" minor L.
Dianthera americana L.
Cephalanthus occidentalis L.
Galium trifidum L.
" asprellum Michx.
Sambucus canadensis L.
Campanula aparinoides Pursh.
Eupatorium purpureum L.
" perfoliatum L.
Solidago uliginosa Nutt.
" patula Muhl.
Aster puniceus L.
" puniceus lucidulus Gray.
" paniculatus Lam.
Leptilon canadense (L.) Britt.
Eclipta alba (L.) Hassk.
Bidens cernua L.
" comosa (A. Gr.) Wieg.
" discoidea (T. and G.) Britt.
" frondosa L.
" trichosperma (Michx.)Britt.
" trichosperma tenuiloba (A. Gr.) Britt.
Erechtites hieracifolia (L.) Raf.

NEW SPECIES OF DIPTERA OF THE GENUS ERAX.

James S. Hine.

The various species of Asilinae known by the generic name Erax have been considered difficult for a long time. This largely comes from the fact that the genus has not been treated with reference to all the North American species included, but various writers have described such species as have come to their attention in collections that have been made here and there throughout the country. From the study we have made of various species with a view to a treatment of the entire genus eventually we are convinced that quite satisfactory characters are available for the separation of the various forms when they are assembled so that careful comparison may be made. But until that time comes students may depend upon it that they will have abundance of trouble in their attempts at determining these rather large and attractive insects, even though they may appear easy to one unacquainted with them.

In western North America there is a group of species of the genus with two submarginal cells, the first of which is long, or with its base distinctly anterior to the base of the second posterior cell. In the male the abdomen is entirely or in large part silvery-white pollenose and two or more of the segments are furnished with long white hair which is parted at the middle and directed outward. The costa is not expanded and a thoracic crest is never present.

Williston and Osten Sacken have named four species of the group, stramineus, dubius, splendens and rapax and six others are described in this paper. It seems that stramineus and rapax are very much alike and I am not sure but that they are one species. I have seen other undescribed species from the Pacific coast region.

Erax rapax Osten Sacken. Mystax straw-yellow, legs black except the bases of the tibiae which are reddish, clothed with abundance of straw-yellow hair and scattering black bristles. Wings hyaline. Length 18 to 23 millimeters.

Palpi black with straw-yellow hairs, beard pale yellow, occipito-orbital and ocellar bristles black, face and front yellow pollinose. Thorax yellowish-brown pollinose with pale hairs on the sides and black hairs and bristles on the dorsum, but the vestiture of this region is somewhat variable and specimens occur with these bristles and hairs partly yellow.

First two segments of the male abdomen colored like the thorax, segments three to five silver white and, except seven, furnished with white hair parted at the middle and directed outward; the posterior part of the second segment may show a few white hairs

directed outward in some specimens. Hypopygium rather large with an extension at the apex and clothed with rather long yellow hairs among which are some black ones.

Female abdomen nearly uniform yellowish pollinose with pale hairs, ovipositor about five millimeters in length, equivalent to the last three abdominal segments. Several specimens from Colorado and New Mexico.

Erax dubius Williston. Gray all over, femora black, tibiae and tarsi red, the latter somewhat darker than the former, tibiae with apices somewhat darkened. Total length of the male, 21 millimeters.

Mystax and beard white, ocellar bristles rather large and black, occipito-orbital bristles mostly black, otherwise the hairs and bristles of the rear of the head are white, palpi black and clothed with white hairs; legs with black bristles and white hairs, on the tibiae this white hair is long and conspicuous, but on the femora it is in large part short and recumbent; wings hyaline, very slightly darkened at extreme apex; thorax gray pollinose, most of the hairs and bristles of the dorsum black, of the sides white, scutellum with white hair, and black bristles on the margin.

First four abdominal segments with long white hairs which on two, three and four are parted at the middle and directed outward, fifth and following segments white and with very short white hairs. Hypopygium from above narrower than the last abdominal segment, black, with hairs mostly white, apex truncate except that the upper part of each valve is extended backward and inward toward its fellow of the opposite side thus producing a prominence from lateral view.

I take this to be the species to which Williston gave the name dubius in the Transactions of the American Entomological Society XII, page 64. No description of the species appears to have been written but the name is inserted in the key and enough characters pointed out to make identification reasonably certain. There are two males before me from southern Arizona.

Erax argentifrons n. sp. Much like rapax. Front white pollinose, mystax white, legs with white hair. Length 18 to 23 millimeters.

Palpi black with white hair, occipito-orbital and ocellar bristles black, antennae black, first two segments with white hair, beard white. Thorax yellowish-brown with the usual middorsal stripe darker, hairs of the sides almost uniformly pale, of dorsum variable between pale yellowish and black; wings hyaline, legs black, except the extreme bases of the tibiae which are reddish-yellow, clothed with white hairs and black bristles.

First two segments of the male abdomen colored like the thorax, segments three to seven inclusive silver white, apex of two, all of three and four with long white hair parted at the mid-

dle and directed outward, hypopygium much narrower than in stramineus, clothed with black and white hair, and distinctly notched at the apex.

Female abdomen uniformly yellowish pollenose and clothed with pale hairs, ovipositor about four millimeters in length, equivalent to the last three abdominal segments.

Specimens of both sexes taken in Clark County, Kansas, by Dr. F. H. Snow.

As has been stated the species has much the appearance of rapax, but the somewhat stouter form, the white mystax and beard and much slenderer hypopygium designate it as wholly distinct from that species.

Erax truncatus n. sp. Thorax yellowish-brown, above, abdomen gray, first four segments with long white hair, legs black with the exception of the basal part of each tibia which is light reddish. Total length 22 to 30 millimeters.

Mystax and beard white, ocellar, occipito-orbital and a transverse row of bristles on the dorsum of the prothorax black, palpi black with black and white hairs intermixed, dorsum of the thorax, and the scutellum with many black hairs and bristles but there are some white ones intermixed, wings hyaline.

First segment of the male abdomen with long white hairs on each side, second, third and fourth segments with long silvery hair parted at the middle and directed outward, fifth, sixth and seventh segments silvery white pollenose but without long hair; hypopygium rather large, from dorsal view about as wide as the last segment of the abdomen, from side view most prominent near middle above and cut off at tip so as to give a truncate appearance.

First seven segments of the female abdomen silvery white, ovipositor slender, shining black, about seven millimeters in length.

Several specimens from the Huachuca Mountains, Arizona, July 28, 1907.

The large compact hypopygium of the male and the long ovipositor of the female give this species a distinct appearance which makes its separation from others easy.

Erax pallidulus n. sp. A pale colored species with black legs and hyaline wings. The male has the hypopygium small and, from dorsal view, very narrow. Total length, 18 to 28 millimeters.

Mystax very pale yellowish, beard white, palpi black with white hair, occipito-orbital and ocellar bristles mostly black; thorax dorsally pale yellowish gray with short black hair anteriorly and black and white bristles and hairs posteriorly, scutellum with pale hairs and bristles, legs black, except bases of tibiae which are pale, wings hyaline.

Male abdomen silver white, first four segments with long white hair, two, three and four with the hair parted at the middle and directed outward, five, six and seven without long hair, hypopygium small, black, narrowed toward apex where, from lateral view, it appears nearly evenly rounded.

Three male specimens from Albuquerque, New Mexico, collected by J. R. Watson.

Erax argyrosoma n. sp. Body nearly uniformly white all over, middorsal stripe of the thorax not plainly marked. Length, 23 to 25 millimeters.

Mystax and beard white, palpi black with white hair, some of the occipito-orbital bristles black and some white; legs black except the basal parts of the tibiae which are yellowish-red, wings hyaline; anterior part of the dorsum of the thorax with short black hair, posterior part and the scutellum with black and white bristles and hairs.

First four abdominal segments of the male with long white hair, on two, three and four; this is parted at the middle and directed outward, segments five, six and seven, silver white but without long hair, hypopygium black with short white hair, some what notched at the apex with the lower part extended into a prominence.

Female abdomen gray pollinose, ovipositor shining black, four millimeters in length.

Taken by J. R. Watson near Albuquerque, New Mexico.

Erax inflatus n. sp. A dark colored species with the mystax composed of black and gray hairs intermixed, wings hyaline, slightly fumose at apices, legs black with the exception of the extreme bases of the tibiae which are yellowish-red. Length of the males 20 to 25 millimeters, of the females 22 to 26 millimeters.

Front yellowish-gray pollenose, antennae black, first two segments clothed with gray hair, occipito-orbital bristles and ocellar bristles black, mystax composed of black and gray hairs intermixed, beard silky white, palpi black with black hairs; thorax brownish-gray pollinose with a dark middorsal stripe abbreviated posteriorly, clothed with gray and black hairs and bristles existing in different proportions in different specimens; legs black, except the extreme apices of the tibia which are yellowish-red, furnished with white hairs and black bristles and some golden pile on the under side of some of the segments; wings hyaline, slightly darkened at the apex.

Male abdomen with the apex of the second segment and all of the segments from three to seven inclusive silver white, segments two and three with long white hair parted at the middle and directed outward, four and five shows this arrangement somewhat but the hairs are short; hypopygium clothed mostly with white hair, enlarged at apical half until it is nearly twice as wide as the seventh abdominal segment.

Female abdomen with each segment white pollinose at sides and apex, otherwise black above, ovipositor black, scarcely five millimeters in length, equivalent to the last three abdominal segments.

Twenty specimens received from F. Grinnell, Jr., and taken in Los Angeles County, California. A very distinct species on account of the male hypopygium which appears as if inflated and is nearly twice as wide as the seventh abdominal segment.

Erax nemoralis n. sp. A dark colored species with yellowish mystax and fumose wings. Femora, tarsi and apices of the tibiae black, bases of tibiae reddish-brown. Length, male about 25 millimeters, female to the tip of the ovipositer, 24 to 27 millimeters.

Face and front covered with yellowish dust, mystax and beard pale yellow, occipito-orbital and ocellar bristles black, as are most all of the hairs and bristles of the front, palpi black, furnished with many black hairs which often are intermixed with pale yellow ones. Prothorax mostly clothed with pale hairs, remainder of thorax with many black hairs and bristles, but these often are reduced by the presence of greater or less numbers of pale ones; middorsal stripe dark and well marked, abbreviated behind and divided anteriorly, on either side the markings are in the form of ill-defined spots caused by the difference in intensity of the rust-colored dust which gives the thorax its peculiar color; legs black except the bases of the tibiae which are reddish-brown, clothed with black bristles and pale hairs of different lengths, the shorter ones recumbent, some of the segments inwardly, more especially the metatarsi and front tibia, clothed with golden recumbent pile.

In the male abdominal segments one, two and base of three dark, largely clothed with black hair, apex of three and all of four, with the exception of a small black triangle on each anteriorly, white with long white hair parted at the middle and directed outward, five and six silver white with very short hair, remainder of the abdomen black, with black hair, however, in some specimens part of seven is whitish and there may be a few pale hairs on the hypopygium.

In the female the segments of the abdomen are gray on the sides and hind margin, otherwise black above but the latter color is not well defined, especially if viewed with a lense; ovipositor about six millimeters in length, equivalent to the last four abdominal segments.

Several specimens of both sexes procured in a brushy woodland at New Roads, Louisiana, July 15, 1905. The specimens were captured while resting near or on the ground. It is a predaceous insect of possible value on account of its size.

THE ANCIENT VEGETATION OF OHIO AND ITS ECOLOGICAL CONDITIONS FOR GROWTH.*

Alfred Dachnowski.

It is generally agreed that the life relations between plants and their habitats are an outcome of certain definite processes linked inseparately with the past. Whatever the possible method of evolutionary advance, whether under pressure of unusual environmental conditions or of different inherent irreversible, limits of organic variability, the behaviour of plants under analytical experimental tests will continue to contribute the generalizations of real interest and importance. The facts and the conditions of the present alone can aid in the interpretation of the past.

The comparatively abundant information which we possess as to the present vegetation in aspect, form, structure and function as related to differences in physical, chemical and biological factors is in striking contrast to the absence of a correlation of similar data as regards environmental conditions during geological periods. From the point of view of Ecology, either as geographic ecology interpreting similarities and differences in vegetation identifiable with factors of latitude and climate, physiographic ecology constituting evidence of more local and genetic forces and concomitant organic response, or physiological ecology which is less floristic in aspect than either of the preceding views and which offers the adequate basis of organic response from experimental evidence of the physiological behaviour of plants under known conditions, to one and all the vegetation conditions of the past are of considerable value, whatever the method of endeavor to understand the factors which the fossil plants record. Those who have confined their ecological study to the environmental investigations of the present must sooner or later test and supplement their investigations by reference to the past. And the aim should be to reproduce not only an accurate fragment of botanical history from the study of fossils and their respective strata, but to correlate structural characteristics with physiological conditions of growth, applying the knowledge of relations gained from living plants. Whether or not the data can be accepted as sound links in the chain of evidence rests largely in the value of the experimental work at hand and in the degree with which they interpret many apparent anomalies.

The limiting climatic and physiographic features which characterize bogs, and the structural features and functions of the vegetation peculiar to them, have seemed to the writer of sufficient interest to invite attention to an inquiry on the probable

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cause of the xerophily of many of the carboniferous plants which lived in swampy areas. The present paper is intended therefore, as a continuation of the ecological studies which appeared from time to time on the vegetation of an Ohio bog and peat deposit. (7–10). The problems involved in the following discussion are by no means to be solved within the limits of this paper; merely an adjustment of perspective is made, leading from a consideration of the fossiliferous plant remains of the coal measures of Ohio.

In attempting to sketch an outline of the geological history of Ohio it is obviously impossible to go into any details of description, or closely follow the development up to the present. At most only the briefest introduction can serve and only a general resume can be noted here. For the specific Geology of the state and a fuller treatment of the subject, the reader is referred to the volumes of the Geological Survey of Ohio and to the literature here cited.

Were we to make a rock section deep enough to reach to the lowest limits of the known stratified deposits, to the great foundations of the continent, the geological strata underlying the state would show as a stage of early growth a predominance of limestone and shale in the lower half of the section, and as a stage of relative maturity widespread horizons of sandstone and conglomerate in the upper half of the section. The strata would characterize the gradual dominance of atmospheric over hydrospheric and volcanic action in a succession of changes, often interrupted and repeated, of which a mountainous elevation and the graded plain near sea level are the extreme forms in the physiographic cycle.

The strata belong to five principal divisions or ages which named in ascending order are as follows: Lower Silurian or Ordovician; Upper Silurian; Devonian; Sub-carboniferous or Mississippian; and Carboniferous, Pennsylvanian, or Coal-Measures. Over the northern and north-western half of the state these are covered by heavy beds of clay, sand, and bowlders which taken together constitute glacial drift. No evidences have been found in Ohio of that group of strata below the Ordovician known as the Cambrian, and pre-Cambrian (Laurentian, Huronian and Keweenawan), or the great series of systems comprising the Mesozoic and Tertiary time divisions. They either left no record within the limits of the state, or much erosion must have taken place immediately succeeding their formation.

Each of the rock systems is again subdivided, and inasmuch as the new stratigraphical divisions are coming into use more generally and are replacing the geological names of the older surveys, the following table taken from Bulletin 7, (21), has been added to show the place in the scale, the relationship of old and new names for the formations, and the thickness assigned to the various formations:

GEOLOGICAL SCALE OF OHIO.

Orton, 1895.	Prosser, 1905.	Thickness
Glacial drift.	Alluvium and Glacial.	0–550′
Upper Barren Coal Measures.	Dunkard formation.	525′±
Upper Productive Coal Measures	Monongahela formation.	200–250′
Lower Barern Coal Measures.	Conemaugh formation.	400–500′
Lower Productive Coal Measures	Allegheny formation.	165–300′
Conglomerate Group.	Pottsville formation.	250′±
Sub-carboniferous limestone.	Maxville limestone.	25′±
Logan Group.	Logan formation. Black Hand formation.	100–150′ 50–500′
Cuyahoga shale.	Cuyahoga formation.	150–500′
Berea Shale.	Sunbury shale.	5–30′
Berea grit.	Berea grit.	5–175′
Bedford shale.	Bedford Shale.	50–150′
Ohio shale. { Cleveland shale. Erie shale. Huron shale.	Ohio shale. { Cleveland shale. Chagrin formation. Huron shale.	300–2600′
Olentangy shale.	Olentangy shale.	20–35′
Upper Helderberg or Corniferous limestone.	Delaware limestone. Columbus limestone.	30–40′ 110′
Lower Helderberg limestone, or Waterlime.	Monroe formation. { Lucas limestone. Sylvania sandstone. Tymochtee member (?)	50–600′
Niagara Group. { Hillsboro sandstone. Guelph or Cedarville limestone. Niagara limestone. Niagara shale.	"Niagara Group." { Hillsboro sandstone. Cedarville limestone. Springfield limestone. West Union limestone. Osgood beds.	150–350′
Clinton limestone.	Clinton limestone. Belfast bed.	10–50′ 50–150′
Medina shale.	Saluda bed.	20′±
Hudson River Group.	Richmond formation. Lorraine formation. Eden shale.	300′± 300′ 250′
Utica shale, not seen in outcrop.		
Trenton limestone.	Trenton limestone.	130′

Thus the LOWER SILURIAN or ORDOVICIAN system includes the lowest of Ohio's stratified and fossiliferous rocks, the Trenton limestone and the several formations of the Hudson River group. They suggest that a broad but shallow arm of an ancient ocean then covered Ohio. (5). As in the following geologic periods, the sediments were derived from the various rocks carbonated, oxidized, and exposed to erosion and solution, the beds of limestone representing for the most part an accumulation of comminuted particles of shells and lime-secreting plants in a clear sea, and the shales representing the deposits of mud made in still water nearer the land. The adjacent lands were probably too low or too far away to yield abundant sand or permit wave-action sufficiently vigorous to keep the mud from settling. Comparatively very few fossil plants of Ohio have been obtained from the geological formations of this period (17); but the records of the life of the era in the United States and in Europe though meager, are sufficient to indicate that development of life was well advanced long before the known strata were deposited, and that less diversity of climate existed than now. The testimony of the ancient organisms implies nearly uniform soil conditions. The plant forms, which in such rocks must necessarily be rare as fossils, were relatively simple, living along the shore and in open water in definite zones, and appear to have varied with the nature and the slope of the bottom, the depth and clearness of water, etc., much as it is today. Immense quantities of microscopic unicellular plants were undoubtedly present as plankton in the protected bays with sandy and muddy bottoms to form the food supply for the large and varied fauna of that time. At the close of that period a folding resulted in an uplift of a broad, flat island-like area about Cincinnati. This arch known as the Cincinnati axis traversed in a northeasterly direction from Tennessee and Kentucky to the lake basin into Canada. From that time on Ohio was nearer sea-level and in places the land areas were so far elevated as to allow sluggish streams and basins, bordered by plants (13, 4, 11).

The UPPER SILURIAN period includes the Saluba and Belfast beds, the highly crystalline Clinton limestone, the several elements of the Niagara group, and the Monroe formation. It extended over a vast period of time, pointing to oscillations of level which covered wide ranges of latitude. The great lagoons and inclosed salt-water basins which were present suffered rapid evaporation. They are signs indicating that an unusually arid atmosphere prevailed. The severity of the conditions restricted life almost wholly to the lowland and the shore of other more favorable regions. Probably the Arctic regions were then the most favorable for growth and development. The fossil plants are few and at times of doubtful affinity; the data are altogether inadequate to give any idea of the vegetation and its ecological conditions for

growth. This relative absence of fossils, together with the character of the sediments, the frequent aeolian crossbedding and frequent mudcracks—are the mark of periods of exposure; they point to near-shore deposits if not to land origin, and to conditions of aridity with tropical climate. This does not mean, however, that a prolific vegetation and perhaps of an advanced order did not exist. Though nothing that can be called a land flora existed, or at least is yet known, the plants of the following period show such marked differentiation and the ancestral relations are so uncertain, that a long previous history, or else a rapid evolution and extinction of intermediate forms would be the only alternatives on which to base an interpretation. A number of species common to Kentucky, Michigan and some parts of Europe have been described; among them are Buthrotrephis ramulosa (16), which bears a close resemblance to Galium (Bedstraw), and Trichophycus venosus, regarded as a plant from the Eden and Lorraine formations. The animal fossils have many characteristics in common with the European Siluric.

The sea again invaded the land and submerged it wholly. A general period of quiet prevailed during the larger part of the following, the DEVONIAN AGE. Toward the close of the Mid-Devonic renewed emergence was accompanied by erosion. The era includes the Columbus and Delaware limestones, and the Olentangy and Ohio shales. Where the changes in the relations of land and water were favorable, a rapid intercontinental migration and expansion of life followed, checked only by barriers and by occasional submergence. The record of plants (18) is too imperfect in Ohio for definite discussion, but fossil evidences show that gigantic marine algae were abundant in the seas together with fish and ostracoderms, while on the land-islands then exposed, there were insects, and mollusks, and in the flat lowland surfaces were broad marshes covered with plants, the larger number of which were herbaceous and highly differentiated. The Devonian plants of contiguous areas show no annual rings to bear evidence of seasonal changes in temperature or intervals of prolonged drought (25). The flora is far richer than that of the Silurian, and of great botanical interest, since in this period occurred great migrations of plants from the Arctic regions, and the development if not the actual beginning of land plants. These facts suggest distinct edaphic as well as other environmental changes. The great inland basins contained a vegetation archaic in many features yet not unlike that now living in swamps and in the tropics. The plants were largely the primitive forerunners of ferns and their allies, and the lower fern-like gymnosperms with an undergrowth of soft thallose forms, very much like the liverworts of today; their decay was accelerated by bacterial action (22). The Devonian types were in many respects similar to those

of the Carboniferous period, and as the latter are much better preserved and represented in the Coal flora, a conception of their ecological conditions for growth may be deferred with advantage until the discussion of that period.

A renewed expansion of the sea entrapped the fauna and flora in beds of sediment of great depth. This organic matter is the chief source of the oil and gas in use today. It is impossible as yet to state with certainty how these fuels have been formed and concentrated. Chemists suggest an inorganic origin for these products. It is thought, and the theory is supported by laboratory experiments, that the great supplies of petroleum were produced through the agency of iron carbides within the earth, generating the hydrocarbons upon access with percolating water. But the quantities traceable to such a source are insignificant in comparison with the great repositories containing the oil. Buried accumulations either of plants, animals or both can alone account for the origin of gas and oil under the observed conditions. The production of hydrocarbon compounds has been studied in coal mines as the "fire damp," in bogs and swamps as "marsh gas" and in the fermentation of cellulose by anaerobic bacteria. Seaweeds and diatoms are known to contain globules of oil; other oily substances of organic origin are the "cholesterol" found in plants and the fatty parts of animals. The optical phenomena of organic oil, that is, the power of rotating the plane of polarization of light, is not shown by inorganically formed hydrocarbons. In nature an accumulation of organic debris, the exclusion of air, and the existence of an impervious protecting sedimentary stratum seem to be the essential condition toward rendering the process of distillation and transformation possible. It is often surprising the quantity of oil which an apparently dense rock stratum can hold. Pressure, temperature, viscosity, the nature of surrounding rocks, and a flow of the liquids and gases into porous rocks and cavities, no doubt, must all be taken into account when considering the changes involved in the origin of gas and oil; but at present the organic origin of these fuels seems to have the strongest support (2).

The Sub-carboniferous or Mississippian period which followed the interval of widespread submergence consists of the Bedford shale, Berea grit, the Cuyahoga, Black Hand, and Logan formations, and the Maxville limestone. An increased land area gave increased contact between the atmosphere and the rocks. In the western half of Ohio the period was one largely of sea extension. Disintegration and much erosion must have taken place to give the sedimentary material of the equivalent formations. A gulf which extended east of the great arch-island enabled plants as well as animals to flourish in isolation for a period sufficiently long to differentiate species of its own. For Ohio the

record of plant life is poor (24). But enough fossil vegetation has been recovered in the surrounding states to show that all the leading groups of the Devonian flora were represented with an associated insect life. The different areas exhibit distinct floral and growth-form differences, and suggest either barriers or differences of water content in the soil. The plant associations are varied and of several aspects. The vegetation is remarkably cosmopolitan in distribution which would premise the absence of climatic zones. Many plants exhibit a striking xerophily; the leaves are reduced to linear organs, the stomata have special constructions and are heavily coated and hardened; the stems show development of water storage tissue; the roots are extended horizontally. The general desiccation effects of the habitat resulted, however, not in the extermination of plants favoring free water, but in the limitation of their functional activity to periods of moist or rainy seasons and in the increase of functional responses. The differentiation has become a factor in distribution and has given the plants a greater range of dispersal; the new place-functions had a survival value in the competitive struggle among the organisms, and in the environmental selection. These phenomena, as will be shown below, are not suggestive of greater severity of climate, but indicate unfavorable conditions in the peaty substratum of the marshes.

The era was brought to a close by an emergence of considerable areas of shallow lowland which with their vegetation constitute the great CARBONIFEROUS or PENNSYLVANIAN system and its important Coal-measures. The land area of Ohio grew in spite of the fact that it was periodically depressed and degraded. The withdrawal of the sea ultimately resulted in the union of separate land masses and the extension to its present borders. The formations are a series of beds somewhat unlike any heretofore considered. Irregularly distributed through the Carboniferous series are six or eight strata of sandstone, part of them conglomerates, characterized by the presence of quartz pebbles which sometimes are of large size. Next to them are beds of shale in great variety of colors; they are frequently replaced with sandstone layers or sheets of limestone. The former are frequently crossbedded, the agents of deposition being rivers or the wind; the latter are all of them thin and partly of fresh water origin, and partly of marine origin as is shown by the abundant fossils which they contain. The limestones are in many cases deposits of a calcareous nature, and frequently associated with beds of iron ore or with a layer of clay of varying degree of purity. The clays are always overlain with seams of coal ranging from a mere black line to a dozen feet and more in thickness. Each of these coal seams stands for a former low and undrained land surface and its vegetation cover. The well-marked order of arrangement of the strata

underlying the coal seams is intimately connected with a long-continued growth, sudden submergence, and subsequent fossilization of marshes adjacent to an ancient sea, and of great inland xerophytic vegetation formed in island-like masses very much like the peat bogs of today, but over much wider areas than any single present day bog occupies. The Carboniferous system includes the Pottsville, Allegheny, Conemaugh, Monangahela and Dunkard formations, all of which have been described in great detail in the later volumes of the Geological Survey. Over these rocks of at least two-thirds of Ohio are spread in varying thickness the deposits of the glacial drift. The glacial formations of Ohio have been very fully described by Leverett (12); a brief account follows in another paper in connection with the present distribution of vegetation in Ohio lakes and peat deposits and the physiography of the state.

The mode of arrangement of all geological formations is that of sheets resting one upon another, but not horizontally. Slow and comparatively gentle movements of the earth's crust, unaccompanied by fractures or displacements have given rise in the state to a system of northeast and southwest foldings. The most important of these is, as has been stated at the outset, the Cincinnati axis which traverses the state as an arch from Cincinnati to the lake shore and beyond into Canada. The other lines of elevation are relatively weak and come into Ohio from Pennsylvania and West Virginia, and are known respectively as the Appalachian fold, the Fredericktown and Salisbury anticlines, and the Wellsburg, Cadiz, and Cambridge anticlines, located near places of that name. They are undoubtedly folds of the great series to which the Allegheny mountains of Pennsylvania and West Virginia belong. This emergence of the rocks of the state has its approximate date at the close of the Lower Silurian period, and has never been more than a low mountain chain.

Along a large part of the Cincinnati axis the strata which once arched over it have been extensively worn away. They are found resting in regular order on either side. The geological map of Ohio recently published shows the areas covered by the principal systems and their series of strata. In the region about Cincinnati the erosion has been greatest, exposing there the oldest rocks. The direction of the draining streams of the western half of the state has been mainly determined by this great anticlinal axis. It forms the divide between the waters of the Scioto and the Miami, and between the Sandusky and the Maumee. On the east side of the anticlinal axis the rocks dip down into a basin in which all the strata form trough-like layers, their edges outcropping eastward on the flanks of the Allegheny mountains. The older rocks are deeply buried, and the surface is here underlaid by the highest and most recent of rock formations, the Coal-

measures or ancient vegetation deposits. In the northwestern corner of the state the strata dip northwest from the anticlinal axis and pass under the Michigan coal basin, precisely as the same series east of the anticlinal dip beneath the Allegheny coal field, of which Ohio's coal area forms a part.

The well-marked order of arrangement which the coal fields of Ohio present, suggests that at the beginning of the Carboniferous age an arm of an ancient shallow lake extended inland and continued in an unbroken sheet up to the Cincinnati arch which made its western boundary. Year after year for many centuries an exceedingly dense luxuriant growth of vegetation covered the surface of the shallow basins as scattered swamps and bog-like marshes sometimes running into a long connected chain, and sometimes quite isolated. The vegetation was doubtless of many kinds of trees, especially giant ferns and club-mosses, with an undergrowth of shrubs, and plants like grasses and sedges. There were many minor differences between the vegetation of different basins; zones of predominating lycopods alternated with ferns. The vegetation must have moved into the open water of protected bays and inland water basins progressively, as groups, distinct in physiognomy and growth-form, the zones varying in width with the definite conditions of life and the selective action of the habitat. The plankton formation must have been followed by plants nearer the margin and submerged along the gently sloping shore lines. Free floating forms similar to Azolla, Salvinia, and to various algae must have existed in great masses, easily transported by winds and currents, at times completely covering the quiet pools. As their debris formed a slowly rising deposit in the basin, the littoral or shore formation must have advanced toward the center of the water basin forming a mat of interwoven rhizomes and roots, harboring various societies and layers according to the light and water conditions. In time the basin became filled with the debris of the vegetation. In many cases the vegetation accumulated to a depth of more than fifty feet, but this great distance from the mineral substratum or the deficiency of mineral substances never rendered it difficult or impossible for the plants to grow luxuriantly. Green plants utilize water and the carbon dioxide of the air to form food, the starches, sugar fats, and proteins necessary to their nourishment and for the successive phases of a normal development. The mineral soil-constituents are not the food of plants; they are indispensable but their amount is very small in organic substances, and alone they are incapable of sustaining life in plants.

Trees standing erect within a bed of coal, their horizontal roots still embedded in the underlying stratum; the corky bark, the wood, branches, leaves, spores, and fruits of many plants, and even the remains of fosil micro-organisms (22) have given their

testimony to what once existed. Though not reported in the Coal-measures of Ohio, the aggregations and often large masses of resinous bodies, amber, fossil coral, and a multitude of similar substances by their varying quantities show the exact character of the vegetation. With the flora many animals commingled; and where they were most abundant, their fossil remains are found. Little is known of the characteristic plants of the upland vegetation. There are descriptions of about 150 species for Ohio (14, 19, 24, 25), but most of the interesting fossil plants were found in the roof of Coal No. 1, that is in the marshes near the base of the Coal-measures. In Ohio this stratigraphical position is "more than two thousand feet above the base of the series, as revealed in the geosynclinal basin of West Virginia, which was first filled with strata of the Coal-measures and long before any similar formations took place upon the ancient marginal Waverly plateau of Ohio" (1.)

The flowering plants (Anthophyta) had not yet appeared. Bacteria (22, 23) and other fungi were present, no doubt, in great abundance. Liverworts and Mosses (Bryophyta) were probably in existence but they still held an unimportant place. There were principally ferns (Pteridophyta) which at this time had reached their greatest development and differentiation. Their first appearance is as strange and distinctive among plants as that of the brachiopods among the animals. They were in part more primitive than now and in part more advanced representing transitional types; but they surpassed all other forms in number and persistency of type. There were scouring rushes (Calamophyta) of much higher and varied organization and of greater height and diameter than the present forms. The several species of the Sphenôphyllales long since extinct, were of tree-like aspect, bearing small wedge-shaped leaves, and sporophylls in cones; most of them are found as undergrowth beneath the shade of giant lycopods. The Equisetales had hollow jointed stems with very small narrow leaves; they are mostly extinct plants of which but one genus, Equisetum, has survived. The Calamariales also long since extinct, grew in dense thickets; they often were of tree-like aspect and dimensions, with narrow distinct leaves in which the stomata were deeply set. The branches and leaves were placed in whorles on jointed hollow stems which arose from underground rhizoms and increased in diameter by the growth of a cambial zone; their wounds were healed by a development of cork. There were the Lycopods (Lepidophyta) the largest of the carboniferous plants, in the form of Lepidodendron and Sigillaria, both with long needle-shaped leaves and stomata in deep furrows on the under side, often protected by a hairy covering; the trees were surface-rooted, the roots spreading out in all directions from the trunk. There were the Cycads (Cycadophyta), fern-like gymno-

sperms related to the modern conifers and flowering plants of which indeed they may have been the ancestors. Of these the best known are Cordaites, Megalopteris, Alethopteris and possibly Lyginopteris with its spiny stem and highly dissected xerophilous foliage, Bennettites, and perhaps Ginkgo. All these were strikingly cosmopolitan in distribution, extending to high latitudes. They were at their climax of vigor and height, and verged into more recent types.

How the coal fields were formed hundreds of centuries ago may be seen at any of our lakes today. Our lakes and ponds represent only one of the several conditions under which vegetable matter accumulates. Other but less important ways possible to form coal beds are accumulations (1) built up from the ground by successive elevations of the water table; (2) in sea bottoms beneath "sargasso" vegetation; and (3) in marine swamps including mangrove swamps and coastal salt marshes. The slight admixture of sediment which indicates the absence of waves, tidal currents, wind-formed currents and eroding rivers, and the fact that at present only one kind of tree, the mangrove, grows in salt-water, is against the view that the coal was formed in salt-water. No records exist to show that in earlier ages the vegetation of the ocean differed greatly in kind from that now predominating. Ferns and mosses are entirely absent from the ocean; the main marine vegetation is still formed by algae, often highly differentiated, which belong to diverse orders. The manner in which the bed of vegetable matter accumulated, and how it was kept from decay, is a long and interesting chapter. The process has been described elsewhere (10) in more detail.

Critical periods suddenly arrived, possibly subsidence accompanied with a deluge of water from an adjacent sea, lake or aggrading stream, carrying silt, burying the vegetation under deposits of mud and sand and converting the submerged portion into dry land. The rise in water level brought with it the recurrence of swamp conditions, but the succeeding shallow lake had a narrower area than its predecessor, and around its shores and in island-like masses flourished again a dense luxuriant vegetation. In long-continued growth it existed, filling the lake with an accumulation of vegetable debris to the depth and the margin which it still retains as the present coal field. During its formation the nature of the sub-soil on which the vegetation grew, and the drainage relations affected then as now the character of the plants predominating in an area, and thus influenced the percentage and kind of ash in the vegetable debris. Frequent local or general disturbances in topography and sedimentation during times of flood brought about the occurrence of partings and seams in coal beds. Not infrequently the vegetation was buried under sheets of limestone that accumulated through precipitation in the invad-

ing water. In the subsequent submergence and fossilization there followed other marshes and bog-like swamps. These coal beds represent in some places submerged forests, and in others the coal was probably formed not by the slow growth of vegetation in situ, but from drifted vegetable material. But every successive coal forming area had a narrower lowland basin than its predecessor. This indicates that the changes in the relative level of water were not accompanied by oscillations in land level.

The geological evidences of the earlier periods of the state's development show that CO_2 existed in much larger quantities than now, since enormous amounts have been fixed in the beds of limestone. The depletion of the CO_2 content, it may be presumed, produced effects on the atmospheric blanket which tended to lower the average temperature and moisture and this changed the climatic character of the region (5). Similarly the tremendous amounts of carbon stored in the basins of the coal measures by the work of green plants undoubtedly produced a marked effect on the atmospheric content of carbon dioxide. Far reaching changes in climate must have followed, such as are exemplified in the periodic glaciations of the Pleistocene.

The duration of the Carboniferous period must have been a very long one to yield deposits of coal of such thickness, for it should be remembered that a large part of the vegetable matter, about four-fifths, escaped as gas in the making of coal, and the remainder has been compressed to a fraction of the original layer of vegetable debris. It is estimated that from 15 to 30 feet of peat are required to make one foot of coal. By a series of changes which are plainly traceable, vegetable matter, peat, lignite, bituminous or soft coal, and anthracite form a series of substances which grade one into another in an unbroken line from complex organic partly oxidized compounds at one end to nearly pure carbon at the other. The succession is not necessarily a strictly lineal one, since degree of decomposition and chemical changes, previous exposure of the vegetation to reduction action or to oxidation, affect the alterations in various ways. The metamorphic changes are hastened where the structural condition of the overlying rock favors the escape of the gaseous products. Ligno-cellulose compounds are the initial substances which gradually loose carbon dioxide, marsh gas and water, and so yield the series of products represented by the different kinds of coal. Chemical analysis (3) in which the probable combination of elements is given grouped as moisture, volatile hydrocarbons, fixed carbon, ash and sulphur show that the value of coal for fuel is determined mainly by the relative amounts of its volatile hydrocarbons and the fixed carbons. The former represents the free burning constituents of coal and the latter its heating power. Ash and sulphur illustrate the objectionable impurities. Up to a

certain point the fuel value or fuel ratio of coal can therefore be determined by dividing the fixed carbon percentage by that of the volatile hydrocarbons. A number of different kinds of coal are recognized in the United States whose differentiation depends largely upon these characteristics. But in whatever variety of form, coal is derived from vegetation which grew in lowland, in ponds and lakes in a manner as we find in sub-tropical swamps and in peat bogs of temperate and northern regions today; it was buried under successive layers of matter like itself, and of sediments such as sand and clay; thus protected from atmospheric oxidation and subjected to gradually increasing heat, and the pressure of overlying porous rocks, the vegetation became transformed to the form we now use. The search for coal today is a search for these ancient marshes, bogs and swamp-forests hidden under layers of sandstone, shales, and drift (20).

What Conditions Determined Xeromorphy and the Origin of Land Plants.

The characteristic xerophily of the carboniferous vegetation has been interpreted by geologists (5) as indicative of a warmer, moister atmosphere, more heavily charged with carbon dioxide than at present. To the writer the facts are hardly consistent with the external conditions assumed. The supposition that xeromorphy involves factors of climate is not necessarily wrong, but calls for a fuller consideration and comparison along with additional factors, the character and magnitude of which is capable of producing like results. A more satisfactory interpretation of the phenomenon of xerophily would be found in the fact that the present vegetation of undrained swamps and of bogs has many of these xerophytic features none of which are correlated with atmospheric influences only. The chief cause for both the xerophily of the coal flora and the great accumulation of vegetable matter is not to be looked for merely in climatic implications. High temperature and humid air promote in a high degree decomposition. The great thickness of the deposits suggests rather that the preservation of the debris was favored by a temperate climate and by agents in the soil such as are involved in the accumulation of peat today. Similarly the force of the inference from the xerophytic aspect of the carboniferous vegetation namely, the peculiarities of leaf size and leaf structure for maintaining a balance between supply and loss of water—gives additional support to the view that the plants encountered adversities of soil-water content rather than of climate. A satisfactory explanation of the phenomenon has been found in the experimental investigations of the writer on the reduction action and toxic character of bog water and bog soil (10), the results of

which are briefly as follows: Poorly drained and undrained water basins and lowlands whether in areas characterized by limestone formations, by sandstone, or glacial drift, become physiologically arid habitats with the accumulation of vegetable debris. Although water is so abundant in bogs and swamps, yet it is largely unavailable to the plants on account of various decomposition products due to the activity of low organisms in the debris-substratum, especially such saprophytes as bacteria and fungi. Peat soils contain bacteria and other fungi in greater number than supposed hitherto, inducing diastatic, inverting, proteolytic, cytohydrolytic and reducing action in the upper layer of the substratum. They vary in kind and number with the nature of the substratum, and show marked interdependence as well as antagonistic action. It has been found that as a general rule there is an accumulation of injurious substances which must be removed if no deleterious action is to follow, and if complete decomposition of the debris is not to be retarded.

The complex and rather ill-defined "humus acids," more specifically humic, ulmic, crenic, and apocrenic acids, are not the important constituents to which peat owes its antiseptic properties and which interfere with the action of bacterial organisms. In Ohio peat deposits, at least, the presence of injurious substances in the substratum is not in direct relation to acidity in the soil. Tests on the reducing powers of peat soils show that the wind driven aeration has little effect on the peat substratum beneath the two-feet level. A shallow superficial zone of oxidation exists in peat soils, and the debris below this is sometimes so charged with injurious decomposition products and gases. and so far unaerated as to be inhospitable to all organisms but anaerobic bacteria.

In the growing season the temperature of peat soil in the more xerophytic of the succeeding bog associations is not below that of other soils. Rapid and passing changes of air temperatures and the occasional extremes do not affect the substratum temperatures. Only average effects prevail and the great periodic changes of the dominant climate. The temperatures of the deeper peat strata indicate that there is scarcely anything of a seasonal descent analogous to the circulation or "overturn" in lakes or in ocean.

The continued growth and persistence of the closely related plant association and the slow succession of vegetation types in a habitat of that character is no longer incomprehensible if we remember that the vegetation grows on top of the accumulating debris and that the water table is always at a high level. The disturbance of the balance produced in the soil is thus not unfavorable to the dominance of the associations. There occur natural successions which are determined, however, not by a deficiency of

mineral nutrients, but by an excessive, defective or preventive action in the substratum. The lack of mineral constituents such as lime, potash, and phosphoric acid does not even render it difficult for mesophytic shrubs and trees to invade and grow as the deposit is built up and oxidation processes become prominent in the surface layer of the substratum. To what extent bog plants require the organic compounds arising in peat soils is still undetermined. The assimilation of organic nitrogenous substances is undoubtedly made less difficult on account of the number of saprophytic fungi and the endotrophic mycorhiza usually present.

The characteristic foliage of bog plants is distinctly an effect to a habitat with a moderate or scanty physiological soil-water content. Extreme xeromorphy is reached in the upper layer of open shrub associations; here the CO_2 percentage of the vertical gradient is least and approximates that of the free air; the combined effect of the intensity of light and the greater saturation deficiency of the air is provided for by an increased thickness of the mesophyll layer in the foliage to minimize disturbances in the carbon dioxide supply. This and the narrow leaves with restricted stomata confined to deep furrows and in some cases protected by hairs, wax, or heavy cuticle, are devices common to plants in bogs where the plants must protect themselves against unfavorable water content in the substratum, and not against unfavorable atmospheric influences. The aerial parts of plants are constantly losing water by transpiration, a process similar to evaporation but controlled by the plants within certain limits. To re-establish equilibrium this water loss is replaced by the supply of water from the substratum by root absorption. The taller plants are thus subjected to a difficulty in maintaining the balance between absorption and transpiration in the same manner as are plants living in deserts or in sandy regions. Though the amount of transpiration exhibited by plants is partly influenced by the physical conditions of the atmosphere such as temperature, humidity and wind, yet these factors are much more uniform than are the amounts of available water supply. The limitations of this paper do not permit going into greater detail in respect to the nature and the degree of toxicity in bogs, or in respect to the kinds of plants or the parts of plants which are most affected.

The nearest analogue of the accumulation and the conditions of growth for the vegetation of the coal measures are the bogs and marshes of today. Were there no other trustworthy records of the occurrence of bacteria and fungi in Palaeozic times (22), it would still be a natural supposition that these organisms were abundantly represented, and produced physical and chemical changes in the substratum. The transformation products of

whatever nature checked the activity of the roots of plants and depressed their transpiration. The striking similarity of the aerial shoots of the carboniferous plants to those of modern times in bogs and undrained swamps restrain one, therefore, from assuming that the atmosphere differed greatly in temperature and humidity, or was different in the chemical constituents from what it is now. There may have been moderate variations in the carbon dioxide content of the air, but this would require experimental proof upon bog plants and the groups of plants similar to those which lived in carboniferous times, the scouring rushes, the lycopods, ferns, cycads and gymnosperms, to assign its limits. The statements in current literature as to the strengths of that gas which green plants can endure are conflicting (6), and call for further work in the field and in the laboratory.

The consideration of these facts leads to another point—the inevitable conclusion that the form characters and the fundamental resistance to drought and dessication distinctive of xerophytic plants whether in bogs or deserts must have made their appearance within early geologic time. They are not of recent development (15). The climate of northern America has undergone oscillations between periods of maximum aridity and maximum precipitation and humidity, with extreme variations in temperature during and following the several glacial periods; the amplitude occupying periods of perhaps many thousands of years. Variations in climate so wide apart indicate an almost complete change in the character of the flora during the geologic periods. The xerophytic features which characterize bogs and deserts are not to be taken, therefore, as having come about by a direct and continuously increasing edaphic or climatic aridity. Aside from the question as to the methods and the activating conditions in evolutionary development, it seems certain that the origin of xerophytic forms is not one of recent development in the vegetable kingdom but must have been concomitant with the diastrophic and gradation processes of the great geologic periods. The great floral evolutions of geologic history were principally one of growth-form, physiognomy, and functional behaviour, and not of floral structure alone. Water has always been the most important of all the life relations in the environment of plants. In the early types of gametophytic vegetation it remained necessarily of greatest importance for the movements of gametes in effecting fertilization and for dissemination. The luxurious development of these forms in the ancient areas of low lying land became checked in the stress of aridity encountered with the accumulation of their debris. With the origin and the development of the sporophytic types of vegetation, which were from the first less dependent upon free water, the prolongation of vegetation activity enabled the plants to occupy the areas with greater

habit reactions. The effects of dessication in the physiologically arid habitats resulted in greater differentiation of organs, in protective and resistance features (9), and in a greater range of dispersal. The vegetation had now developed to forms capable of occupying dry land, and able to maintain themselves as bog or desert vegetation in localities restricting functional activity. The general movement finally resulted in a land flora of which the mesophytes are the highest expression. The lowland basins and regions of coal formation were undoubtedly the regions of the evolution of the flora as a whole and of the several natural plant formations which include many diverse species in a unity of characteristic physiognomy and growth form. Probably the arctic regions were then the most favorable for the growth and development of xeromorphic forms. Migration from northern centers of dispersal, the periods of climatic aridity, and the changes immediately before and after ice invasion, undoubtedly accentuated the ecological evolution of this type of vegetation.

The extensive change in floral types which is particularly evident through the subordination of the ferns to grasses and heath plants, and the elimination and replacement of the primitive gymnosperms by the later gymnosperms and angiosperms is largely one of range and variability of protoplasmic forces. In some types the characteristics often bear no apparent relation to the environment and are retained under the most varied conditions, yet many other types are profoundly and rapidly modified by changes in climate, physiography, and soil processes.

The great development of form in response to the environmental stress was attended by a rapid and luxuriant expansion in range, in successions of vegetation formations, and in sequence of associations. Several forms of cycads, Bennettites and conifers now inhabit desert areas. Not less interesting is the fact that many species of heather-plants of Europe such as Calluna, Empetrum, several species of pines (Pinus sylvestris, P. montana), Juniper (Juniperus communis), birches (Betula, pubescens, B. nana), Labrador tea (Ledum palustre), bladderwort (Utricularia cornuta), and others, can grow both on extremely dry, warm soil and on extremely cold or wet soils. The observation has repeatedly been made by the writer that in the northern parts of Michigan several species of bog plants leave the peat soils entirely and are only found upon dry and poor soils. This is notably the case with tamarack (Larix laricina), the chokeberries (Aronia nigra, A. arbutifolia), the blueberries (Vaccinium corymbosum, V. canadense), the black huckleberry (Gaylussaccia baccata), the shrubby cinquefoil (Potentilla fruticosa), sweet gale (Myrica gale), the steeple bush (Spiraea tomentosa) and several other xerophytes of the peat bogs of Ohio. The cranberries (Vaccinium sp.), creeping snowberry (Chiogenes hispidula), and

wild rosemary (Andromeda polifolia) occur in moist ravines and rich woods, while leather leaf (Chamaedaphne calyculata), the buck bean (Menyanthes trifoliata) and Labrador tea (Ledum groenlandicum) are found along slow streams. The majority of these plants occur in Europe and Asia, in habitats of similar conditions. They are bog plants only in the southern part of their range. This departure is in no sense an adaptation to climatic influences but is an equilibrium relation or balance between the absorbing organs, the conducting shoots and the transpiration surface against drought conditions common to either habitat. The structures and distribution habits are induced by physiological aridity or poverty of available water; morphological limitations in the conduction of water do not play a role. The physiological water relation alone must be taken into account for the form and habits of bog and swamp xerophytes, even if the plants inhabit regions of pronounced rainfall and milder temperatures. The appearance of such differentiation can not be taken as one of rapid and notable evolutionary development or as one of the most important in the history of plants; nor would it be safe to assume that bog and desert floras owe their origin to gradual adaptations resulting from the action of climatic changes. The possibilities of survival are very great for forms thrown into the complex conditions of a locality where the functional and structural capacities are suitable for the limiting physico-chemical factors encountered in the habitat. The plants are functionally fitted to occupy the place in a zone with its system of factors. The qualities of growth which enable competition and the crowding out of other forms are not of primary importance in the struggle and selection where physiological capacities have the survival value for activity during drier seasons. Invaders would not exclude the forms by which a bog or a desert is characterized, except where the influence of external conditions has produced irreversible changes in a hereditary line. The structural alterations in roots and shoots of bog plants can not be looked upon as of comparatively recent origin. The phenonemon of xeromorphy has exhibited itself too generally in a variety of plants of conditions in space and time; as such it is the general response in plants to minimize or balance disturbed physiological water relations.

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NOTES ON THE ANATOMY AND PHYSIOLOGY OF THE UNIONIDAE.*

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The Unionidae are not only the most conspicuous part of our molluscan fauna, but also the most interesting. Some of their anatomical and physiological features have come to our knowledge only recently, and in few groups of animals, have the last ten to fifteen years brought such radical changes of classification. Up to 1900, the genera were generally based upon the shells: those with complete (regarding the family) hinges were called *Unio*, those with more or less defective hinges were *Alasmidonta*, or *Margaritana*, and those without hinge teeth were *Anodonta*. Conchologists generally know that the groups and genera are now established principally on the soft parts, mainly the branchiae, not exactly coincident with the formation of the shells. The branchiae, or gills, of this group of mollusca, have three very different functions: respiration, nutrition (as food gatherers), and as brood chambers for the ova and embryos.

The general morphology and anatomy of the fresh-water mussels is well known, but the special features are frequently not mentioned, or very fragmentarily, in text books on zoology, and not even in recent special works on mollusca. Our lowest form, at least in one group, and in one direction, the small *Anodonta imbecillis* Say, is hermaphrodite, that is: part of the gonad is ovary, another is testis. Other *Anodontae* have not been sufficiently examined in this respect. The balance of our *Unionidae* are typically unisexual, yet among *Quadrula*, and even *Lampsilis* (parva, Barnes), bisexual individuals are occasionally found.

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It is known that the ova, from the ovary, pass through an oviduct on each side into the branchiae, where they develop into embryos, the so-called glochidia. The glochidium, of about the size of the ovum, has a two-valved shell, very different from the postembryonal shell, and also of markedly different formation in the several groups, and a very primitive formation of the soft parts, without alimentary canal, ganglia, branchiae, etc.

The formation of the female reproductive branchiae is varied and furnishes principal characters for classification. In some of the groups, the *Unioninae* (*Unio, Pleurobema, Quadrula*), also the *Anodontinae* (*Anodonta, Alasmidonta, Gymphynota*, etc.), the branchiae which receive the ova, in their whole extent, show only slight and macroscopically barely noticeable differences from the male branchiae, and the non-receptive of the female. In a still higher group, only a part of each of the outer branchiae is noticeably differentiated, the so-called marsupium, consisting of ovisacs, their number being very different in the several groups, and approximately constant in adult individuals of each species. Also their configuration shows differences, when barren, and much more so when charged. This is the group, or subfamily *Lampsilinae*, and, with some differences, *Proptera*. In *Ptychobranchus* (e. g. *phaseolus* Hildreth), the outer branchiae are differentiated in their whole extent, and of a formation markedly different from that of the others, when gravid.

In the lower forms, there are no or slightly marked differences of the shells between males and females. With the appearance of the marsupium which, when filled and distended, projects more or less over the general contour and the lower edge of the branchiae, there comes a corresponding distension of the shell in the female, not or slightly marked in some forms, strongly so in others, e. g., most of the species of *Lampsilis*. It reaches its highest grade in *Truncilla*, where that part of the female shell is not only greatly distended but also of a formation and sculpture different from the rest of the mussel.

These differences, gradations, of both soft parts and shell, are naturally not in a straight line, the same as in other groups of animals, but with ramifications and gaps, which latter would probably be bridged over by extinct forms, and possibly by such as are living in other zoo-geographical provinces.

In connection with the different formation of the gravid branchiae, there are also different ways of discharging the embryos. In the *Unioninae* the young are expelled upward from the brood chambers into the suprabranchial canal and from there out into the water through the anal siphonal mantle opening. But in the *Lampsilinae*, each ovisac opens, at its inferior end, and the contents, coherent as a cake ("placenta"), makes its exit through that rent, and out either through the branchial siphonal

opening, or simply through the great slit of the mantle on the ventral side.

Of the first stages of post-embryonal development, we still know little. It has been observed, in Europe, many years ago, that the glochidia of *Anodonta* attached themselves on fins, gills, etc., of fishes, are there inclosed in a cyst-like cavity by local hypertrophy of the host's epidermis or epithelium, and live as parasites for weeks or months. In our country, some observations of this kind have been made, but I have not seen a report on them. There is an excellent opportunity here for observations and experiments.

At a later stage, small mussels—some less than two millimeters long—are found with post-embryonal shells, still bearing the glochidium valves in the centers of the beaks. Young *Lampsilis* develop a byssus thread, about the thickness of a horse hair, and several inches long, fastened to a stone, or shell. The young mussel begins to develop its gonad in about the third year, and at that age has comparatively few ova and young in its marsupia. Only from that age on, young *Lampsilinae* begin to show sexual differences of the shells.

There is another physiological feature of interest. By examining thousands of specimens at various seasons of many years, it has been found that the mussels of the several groups are producing their young at different times. The *Unioninae*, also *Margaritana*, are found with their branchiae barren through autumn, winter and spring, but ova, and sperms developed in the gonads. In the summer, about June, the ova are transferred to the branchiae develop into glochidia within a week or two, and the young are discharged soon; the whole process taking about four weeks. In the *Lampsilinae*, and the *Anodontinae*, the marsupia become gravid in fall, in some as early as August; the transformation into glochidia here also takes only a week or two, and then the embryos, without any noticeable changes, are retained over winter and early spring, that is for eight to even ten months. The former were called short period or summer breeders, the latter long period or winter breeders.

To sum up: From these condensed and fragmentary outlines, it becomes evident that our Unionidae are not of the simple and uniform organization as was supposed, and that their study reveals many interesting features. For these reasons, they well deserve more attention than has been given them, as an object of study in the zoological laboratory, for their morphology, anatomy and physiology.

In conclusion, it may not be amiss to point out briefly the principle differences between the two groups of our fresh water Pelecypoda: the *Unionidae* of the Naiadacea, and the *Sphaeriidae* (*Sphaerium*, *Mucsulim*, *Pisidium* and *Eupera*) of the Cyrenacea The latter,

of which we have about a hundred species, now known, in North America, and well worth being studied, are of much smaller size, the mussels being 1.5 to 20 mill. long when mature; their hinges are more complete; the mantle is less open and the siphons are closed, and tubes; the four branchiae are differently arranged; the young are developed in a special, brood pouch on the inside of the inner branchiae on each side; the young, when mature, are much larger than the glochidia of the Unionidae and fully developed.

New Philadelphia, Ohio.

THE OCCURRENCE OF APPLE BLOTCH IN OHIO.

W. O. Glover.

In the early part of September of this year there came an inquiry to the Department of Botany of the Ohio Agricultural Experiment Station from an orchard grower of Sharon, Noble County, seeking advice in regard to the blotched appearance of some of the apples found in his orchard. Examination of the specimens, by Mr. Arzberger, of this department, revealed the presence of the Apple Blotch, *Phyllosticta solitaria*, E. & E. This disease was reported by Scott* in 1909 as being quite prevalent in our southern states, causing a great deal of damage in the orchards infected. Investigations in the orchards in the vicinity of Wooster showed its presence on a local variety of apple known as "Butter Apple." All the trees of this variety in the orchard were infected to about sixty per cent of their crop, while other trees under similar conditions were immune.

Inquiries and inspection of the orchards in our southern counties revealed the fact that the apple blotch was quite prevalent in sprayed as well as unsprayed orchards. Usually one variety in an orchard suffers to a great degree while the remainder of the orchard is not infected. In one orchard, for instance, twenty barrels of Pippins were infected to about ninety per cent, while the other varieties were immune. The investigations in Lawrence, Gallia and Jackson Counties showed that *Phyllosticta solitaria* occurred frequently on Smith's Cider, Baldwin, Ben Davis, Stark, Pippin, and Rome Beauty. Often, as was the case with the Pippin, the entire crop was ruined by this disease. The disease has also been found in Wayne, Noble, and Athens Counties.

The fungus is not only found on the fruit, but its presence is also noted on the leaves and twigs; nevertheless, the disease is not suspected in the orchard unless the disease has made itself evident on the apples. The dark-brown stellar spots (Figs. 1 and 3),

* U. S. Bull. 144, Bureau of Plant Industry.

formed by the fungus are irregular in shape, varying from a quarter of an inch to an inch in diameter. However, they may coalesce and cover a larger portion of the apple. Not until the final stages does the fungus penetrate more than a few millimeters below the epidermis where it gives the infected portion a dry pulpy texture.

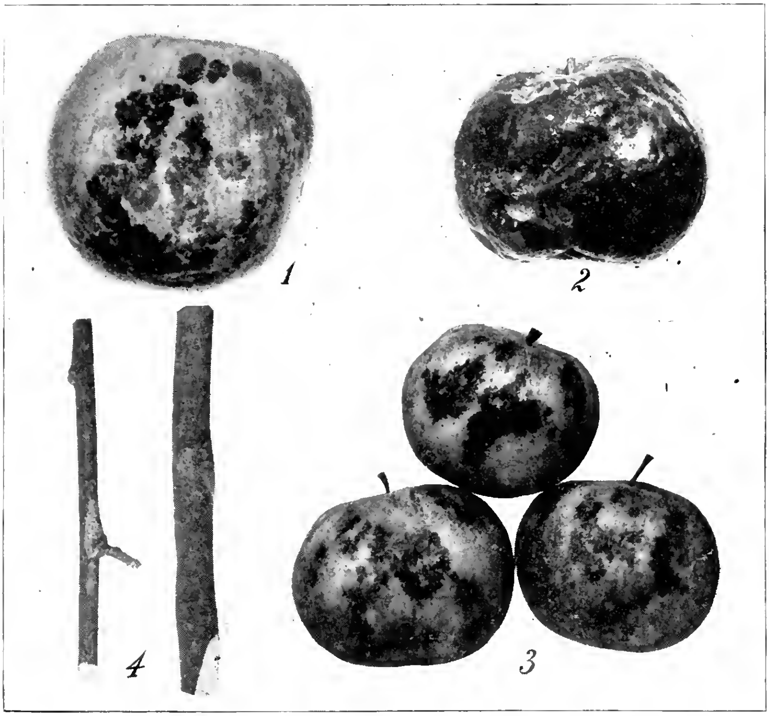

Fig. 1. Apple blotch (Phyllosticta solitaria), showing the nature of the disease.
Fig. 2. Pycnida of P. solitaria and sunken areas of infected tissue.
Fig. 3. A group of Smith's cider apples showing the typical blotches.
Fig. 4. Cankers of P. solitaria on apple twigs.

At the time the apples are about to be harvested the blotches are most prevalent and at this time the pycnidia begin to appear in the diseased spots below the epidermis (Fig. 2). They are not found in any definite position, but generally they are only seen in the older infected tissue at the center. In the mature pycnidia are found the one-celled, ovoid, hyaline spores varying somewhat but usually 9 x 6 microns. In certain cases we have transverse cracking of the infected areas which is soon followed by a general decay.

The fungus is also present on the water sprouts (Fig. 4) and fruit spurs where it forms tan-colored cankers. These cankers on the water sprouts are variable in size, often attaining a length of two inches, and a width of about one-half inch. The cankers on the fruit spurs are smaller, being usually about a quarter of an inch in diameter. However, the cankers are more numerous than on the water sprouts and often give the fruit spurs a very rough, ragged appearance due to the cracking of the cankered tissue. Sometimes the cracks may entirely separate the infected from healthy tissue, and then the canker wound will be healed by the growth of the new tissue which crowds away the infected bark. The pycnidia are found scattered over the entire canker surface and the spores therein are similar to those found on the fruit.

The leaves, when infected with *Phyllosticta solitaria*, show small yellow spots about a sixteenth of an inch in diameter. In the center of these irregular spots there usually can be found one or more pycnidia which contain the spores. The presence of the spots on the leaves are often lacking, especially when the foliage has been protected by proper spraying.

From the trees observed in this state, it is evident that very little infection comes from the infected leaves, but the perennial cankers on twigs, with their numerous pycnidia, are the great source of infection. The blotches, which give the apples their unsightly appearance, begin to appear late in July or in the early part of August and increase in size until harvesting (Fig. 2). These apples when kept in storage soon decay, because, through their injured epidermis other fungi enter.

As to the control of the apple blotch, it is reported by several of the fruit growers that spraying will control this disease. However, it has been observed that the blotch was prevalent to a great degree on certain trees that were well sprayed. The blotched apples in such cases would tend to discredit the use of sprays were it not for the fact that the trees were usually not well pruned, and hence the cankers were allowed to send forth their spores unhindered. It appears that spray treatment must extend throughout the season after the manner of sprays for bitter-rot. Thus it is clearly seen that while spraying is a great factor in the control of the apple blotch, pruning plays just as important a role in checking a disease which is costing many bushels of apples, and which, if not checked, will ruin some of the choice crops in this state.

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PRELIMINARY REPORT ON THE LIFE-HISTORIES OF TWO SPECIES OF SYRPHIDAE.

C. L. METCALF.

For many years it has been well known that the larvae of certain genera of Syrphidae feed upon plant lice (Aphidae) and are important agents in keeping these highly injurious insects in check. It is therefore believed that the following notes on the immature stages of two species of these flies, although incomplete, are of enough interest to warrant this preliminary report.

The work has been done under the able direction of the Professors of Entomology at the Ohio State University. It was taken up at the suggestion of Professor James S. Hine, to whom I am especially indebted for many valuable suggestions and criticisms.

DESCRIPTION.

Didea fuscipes Loew.

LARVA.

Length, 12–15 mm., width 5–6 mm., height 3–4 mm. The larvae are testaceous brown, footless, eyeless grubs. The head is not distinctly differentiated. Shape flattened, sub-cylindrical blunt at the posterior end, tapering and obtusely pointed in front when extended (Fig. 2.) The head segments are usually very much retracted when the larva is at rest giving to the anterior end a bluntly rounded appearance. The body is divided up into twelve more or less apparent segments, each, except the first two and the last, marked by several transverse folds of the integument. On the elevations of these folds in each segment are situated twelve long bristles in a transverse row. Of these the four nearest the mid-

dorsal line crown the summits of prominent conical projections which, like the rest of the dorsum, are close-set with short radiating black bristles. The second of these projections from the middle line on each side is about one-third as large as the first and situated on the succeeding fold. These transverse folds are continued laterally into distinct V-shaped prominences which with those of other segments form a zig-zag longitudinal carina along each side of the body. The third spine from the middle-line on each side is situated at the apex of this V; the fourth at the apex of a similar, underlying lateral cone or V; in front of which a small ventrally-projecting fold forms two smaller spiny prominences bearing the fifth and sixth bristles. These form the lateral borders of the larva and give to it a very irregular outline of sharp angular projections.

On the ventral part of the first segment are situated the mouth-parts and dorsal to these the antennae. The mouth-parts consist of two jaw-like pieces working longitudinally and at the sides of these three pairs of mouth-hooks adapted to work transversely (Fig. 3.) The jaws are continued internally into a tube-like oesophagus or gullet. All the parts are black and firmly chitinised. The antennae are very small consisting of a single fleshy joint with two minute rounded segments side by side at its apex. Surrounding these parts are a dozen or more small sensory papillae.

In the middle of the third segment is a pair of anterior spiracles. These are light brown, conical, with a semi-circular slit near the apex (Fig. 4).

On the anterior part of the dorsum of the last segment is situated the posterior breathing organ (Figs. 2, b; 5). This consists of two closely apposed, short, cylindrical breathing-tubes, united along the middle line, slightly divergent at the tip. They are hard, black, firmly chitinised structures, each with three slit-like spiracles raised on radiating carinae. Anteriorly near the middle line each is marked by a smooth circular plate; and the surface of the appendages between the spiracles bears several sharp irregular ridges. The alimentary canal opens ventrally on the last segment.

The integument of these larvae is exceedingly tough but transparent. The entire dorsal and lateral surfaces are beset with numerous, minute, short black bristles. The ventrum is bare. Along the mid-dorsal line for the greater part of its length the dorsal blood-vessel is visible through the body-wall. It is a poorly-defined, dark line with five or six lateral expansions.

This fly is only tolerably common about Columbus. I was able to find the young fairly common in the autumn of 1909; but they were rare in 1910, owing perhaps to the greater scarcity of their food the latter season. From the observations made it is probable that the larvae of the autumn generation of this fly do not appear before the last week in September or the first of Octo-

ber. The middle of September none were to be found. On October 10, 1910, four larvae of this species were collected from Sycamore. Eight days later one of them pupated. I have not determined accurately the duration in the larval stage.

The larvae of *Didea fuscipes* live in the colonies of the large aphid, *Longistigma* (*Lachnus*) *caryae* Harris which appear so abundantly in fall on the under sides of the lower horizontal branches of the Sycamore (*Platanus occidentalis* L.). I have also found the larvae on a Basswood tree (*Tilia americana* L.) affected with these plant lice. They are apparently closely restricted in food-habits to the body fluids of this one kind of aphid and may be expected wherever *Longistigma caryae* occurs with any regularity. They are rather sluggish and probably often spend their entire lifetime among the particular group of plant-lice in which they hatch.

When feeding the larva seizes an aphid with the hooks of its mouth-parts. The body-wall is punctured and the juices, which alone are eaten, are slowly sucked out leaving the body-wall shrunken and crumpled. These dried-up skins can frequently be found on the branches where larvae have fed. It is my belief that these flies destroy large enough numbers of the aphids to be of considerable economic importance in keeping them in check.

The excrement of the larva is dark purplish in color and leaves conspicuous blotches on the white sycamore bark. The moist excrement seems to be of use in helping the larva to cling to the surface of the bark.

I have discovered no habits of protection in the larval stage more than that derived from the surrounding colony of aphids. They are certainly not conspicuous when so located. The location on the under side of the twigs is no doubt a protection from the weather and from some birds; but this is, I think, entirely incidental to the similar location of their prey. The covering of spines and especially the conspicuous bristly prominences may be defensive.

I have found no particular enemies of this stage.

PUPA.

The pupa is concealed in the hardened, slightly inflated, sub-cylindrical, last larval skin, within which the changes to the adult form take place. As the larva approaches metamorphosis it attaches itself usually to a somewhat protected place on the under surface of the limb. The anterior segments are retracted, the skin becomes inflated filling out the wrinkles characteristic of the larva. It rounds out anteriorly and dorsally, the point midway between the fourth and fifth segments coming to lie at the anterior pole, the mouth being shunted backward on the ventral side

Length 9.5–10 mm., width 4.5–5 mm., height about 4.5 mm. Color, Roman sepia, a little darker than the larva. The puparium is broadest a little back of the sixth larval segment, is nicely rounded in front, and tapers gradually to the last segment which remains somewhat flattened, especially at the sides. The covering of small black bristles is retained and the black conical prominences become even more conspicuous owing to the inflation (Figs. 6, 7). The posterior breathing appendages are retained.

The date of pupation was about the middle of October. Indoors the duration in the pupal stage was about 20 days.

I have made no observations which would indicate that the larvae crawl far before changing to the pupae. I have found pupae on the under sides of the horizontal branches of the Sycamore not far from the colonies of plant lice among which they fed.

The shining brown color together with the black, spiny, conical projections on the dorsal side give to the pupa of *Didea fuscipes* a characteristic appearance easily distinguished from that of the other Syrphidae I have seen. The pupae are protected by the indurated puparium and somewhat by the sheltered position on the bark taken up by the larvae.

I have found the pupa late in November and it is probable that the fly passes the winter in this stage.

The adults have been taken from the middle of May to the last of September. I have studied only the autumn generation of larvae.

The adults emerge by bursting off a circular lid of the pupa case (Fig. 7). This is accomplished by expansion of the lower part of the face

ADULT.

♀, ♂. Length 11–15 mm.

Description, slightly modified from Williston. Bull. U. S. Nat. Mus., No. 31, 89 (1886). Face yellow, with a small elongate brownish spot on the tubercle. Front yellow, with two brownish spots above the antennae, or, in the female, with an inverted V-shaped brown stripe connected with the black of the upper part of the front. Eyes bare. Orbits thickly yellowish pollinose, posteriorly with a fringe of yellowish-whitish pile. Antennae black, the third joint at the base sometimes reddish, elongate oval, obtusely pointed at the tip; arista reddish. Thorax shining greenish black, on the meso-, ptero-, and sterno-pleurae yellow, thickly covered with similar colored pollen and pile. Scuttelum light yellow, translucent. Wings grayish hyaline, the base before the humeral cross-vein and the stigma brown; the remainder of the sub-costal cell and the costal cell may be brownish; third vein rather deeply curved near the middle of the first posterior cell. Legs brown, the posterior tibiae and all the tarsi blackish; sometimes the legs are luteous, the base of

femora, distal portion of tibiae, and the tarsi brown. Abdomen black, with four yellow cross bands, the first consisting of two large ovate spots, narrowly separated and reaching the lateral margins in nearly their full width; second and third cross-bands broad separated from the lateral margins by a black narrow keeled border; they are much narrower in the middle of the segments, the front margin straight, touching the anterior edge of the segments; fourth band similar, but much smaller and attaining the margin; all the black is velvety opaque except the narrow posterior margin of the segments which is shining, dilated in the middle.

Syrphus torvus Osten Sacken

LARVA.

Length, 10–12 mm., width 3–4 mm., height about 2 mm. Shape sub-cylindrical, tapering rapidly in front to the mouth parts, slightly narrowed but blunt and emarginate at posterior end.

The body consists of twelve more or less apparent segments each except the first two and the last crossed by a transverse row of twelve light-colored spines. Ten of these are in line, the most ventral on each side being situated in front of the others. The integument is raised into numerous transverse folds continued laterally into a distinct longitudinal keel on each side (Fig. 10). First three body segments small, retractile, gradually thicker; next eight sub-equal; terminal segment flattened, bearing on its dorsal surface the caudal spiracles. These as in *Didea* are borne upon two short cylindrical approximate appendages and are placed within clefts at the summit of three radially arranged carinae on each appendage (Fig. 13). These carinae are narrower and longer than those in Didea. The rounded plate-like piece is present on the anterior part but the surface shows only a few blunt projections. On the ventral part of this segment is the opening of the alimentary canal. The mouth-parts are terminal and are similar to those of *Didea* except for an additional pair of black chitinous recurved hooklets at the sides (Fig. 11). Surrounding them on the first two segments are a number of small sense papillae (Fig. 11, *h*). The first segment also bears the antennae (Fig. 11, *f*). These are very small, similar to preceding species. Between the second and third segments dorsally is a pair of small brownish anterior spiracles (Figs. 10*a*, 11*g*); conical, the semicircular slit guarded by seven rounded teeth (Fig. 12).

The general color of the larvae is brown pink. The integument is tough but transparent; naked but very finely papillose. The black mid-dorsal blood vessel is more prominent than in *Didea* and in the living active larvae the blood may be seen pulsating regularly from posterior to anterior end. Laterad to this blood vessel are two long yellowish bundles of fat irregularly

outlined extending practically the full length and varying in width. At the approach to metamorphosis these adipose masses increase in extent sometimes covering nearly the entire dorsum except the blood-vessel. At times also the body fluid invades more or less the fatty bodies appearing as outlying pulsating pockets.

This fly is abundant in this region and has been taken from April 1 to September 10. The stages have not been followed throughout the year and the egg has not been studied.

The autumn generation of larvae appears on cabbage affected by plant lice usually during the latter half of September, becoming abundant from the first to the middle of October. During the fall of 1909 the study was not taken up until about the middle of October. At this time larvae were plentiful and were found at the University farm until the first of November when the host plants were removed. When the writer returned to Columbus the middle of September, 1910, very few aphids or larvae of Syrphidae were to be found and none of *Syrphus torvus.* The latter appeared after those of other species, not becoming abundant until the first week in October. They were still fairly plentiful the middle of October.

I have not determined the duration in the larval stage. Some larvae taken Octover 15 and kept on sparse diet remained unchanged December 3, showing their great tenacity of life.

The larvae live on cabbage and related plants crawling about on the surface of the outer leaves and as far inward as is accessible without boring. The food of the larvae is usually the body juices of the cabbage plant-louse (*Aphis brassicae* Linn). I have found some of this species on Sycamore feeding on *Longistigma caryae* but they are much more abundant on cabbage. Confined larvae readily change to the latter kind of food in absence of the cabbage aphids. The larvae are sometimes found on plants on which there are no aphids; but usually there is an abundance of prey at hand.

The louse is seized by the hooks and jaws of the mouth of the larva and held in the air while the juices of its body are sucked out. I have found no particular enemies of this stage. They are often well protected from birds among the inner leaves.

PUPA.

In changing to the pupa the larval skin contracts to form a puparium. The body becomes shorter, more oval, expanded dorsally in front and of a darker color. Length 8–8.25 mm., width 3.5–4.3 mm., height 3.75–4 mm. Testaceous brown, naked, smooth except for slight remains of the transverse wrinkling of larva. (Fig. 14). Broadest in front of the middle, nicely rounded in front, descending rapidly at the posterior end to the projecting caudal spireales (Fig. 15).

ADULT.

Length, ♂ ♀ 10–12.5 mm.

Description, slightly modified after Osten Sacken. Proc. Bost. Soc. N. H., XVIII, 139 (1875).

Female (Fig. 9): Face and cheeks yellow with a very slight bluish reflection, covered with fine scattered yellow and black pile; a faint grayish spot on the cheeks under the eyes; oral margin in front narrowly brownish. Front and vertex shining black with black pile; the front on both sides along the eyes with a broad border of yellowish pollen sometimes meeting the similar border of the opposite side. This pollen continues in dilute form down the sides of the face crossing narrowly beneath the antennae. Eyes pubescent (in many specimens the pubescence is very much rubbed off and very difficult to perceive) posterior orbits covered with white pile and pollen. Antennae inserted beneath a double arched ledge of front. The dark color of the front begins immediately above their root forming a blackish brown arch with a projecting angle in the middle. Antennae dark brown; third antennal joint below and the bare arista sometimes more or less reddish. Face in profile perpendicular beneath the antennae produced but little below the eyes, slightly concave beneath the antennae to oblique tubercle, receding below (Fig. 16). Thorax dull greenish with but little lustre; in well preserved specimens with three faint dorsal longitudinal darker stripes, divergent posteriorly; scutellum dull yellowish with a slight bluish reflection. The black pile of scutellum and dorsum of thorax changes to yellow on the sides of the latter where it is also much thicker and longer. Wings large considerably longer than abdomen. Third longitudinal vein nearly straight; anterior cross-vein a third of the way from base to apex of the discal cell; anterior outer angle of first posterior cell acute. Entire subcostal cell brown; root of wings as far as humeral cross-vein and the costal cell slightly tinged with brown. Legs slender; coxae and basal third of femora black; on the hind pair the black reaches beyond the middle of the femora; hind tibiae often with a brownish ring; four anterior tarsi brown the root of the first joint often reddish; hind tarsi dark brown.

Abdomen oval slightly broader than thorax; about twice as long; with three prominent yellow cross bands, the first interrupted in the middle, all attaining the lateral margins. First segment entirely black; second segment with a yellow elliptical spot about the middle on each side prolonged usually as a narrow neck which reaches forward and touches the margin. Third and fourth segments each with a yellow cross-band on its anterior half, the hind margins of these bands very gently biconvex with a very shallow sinus at the middle; on each side the cross bands are

attenuated and curved forward so as to reach the anterior margin of the segment. The band on the fourth segment also touches its anterior margin in the middle, while that on the third is more remote from the anterior margin; the black interval between the bands is twice as broad as the bands. The fourth and fifth segments have yellow posterior margins, the fifth usually with two yellow spots on each side at the anterior margin.

Male. "Similar to the female but abdominal cross bands broader, the biconvexity on their hind side stronger, and the sinus in the middle deeper; the gray spot on the cheeks under the eye often larger, sometimes occupying a considerable portion of the cheek; the brown ring on the hind tibiae usually expanded so as to reach the tip of the tibiae. The eyes (contiguous) are more distinctly pubescent, the front is beset with yellow pollen except a narrow black space above the antennae."

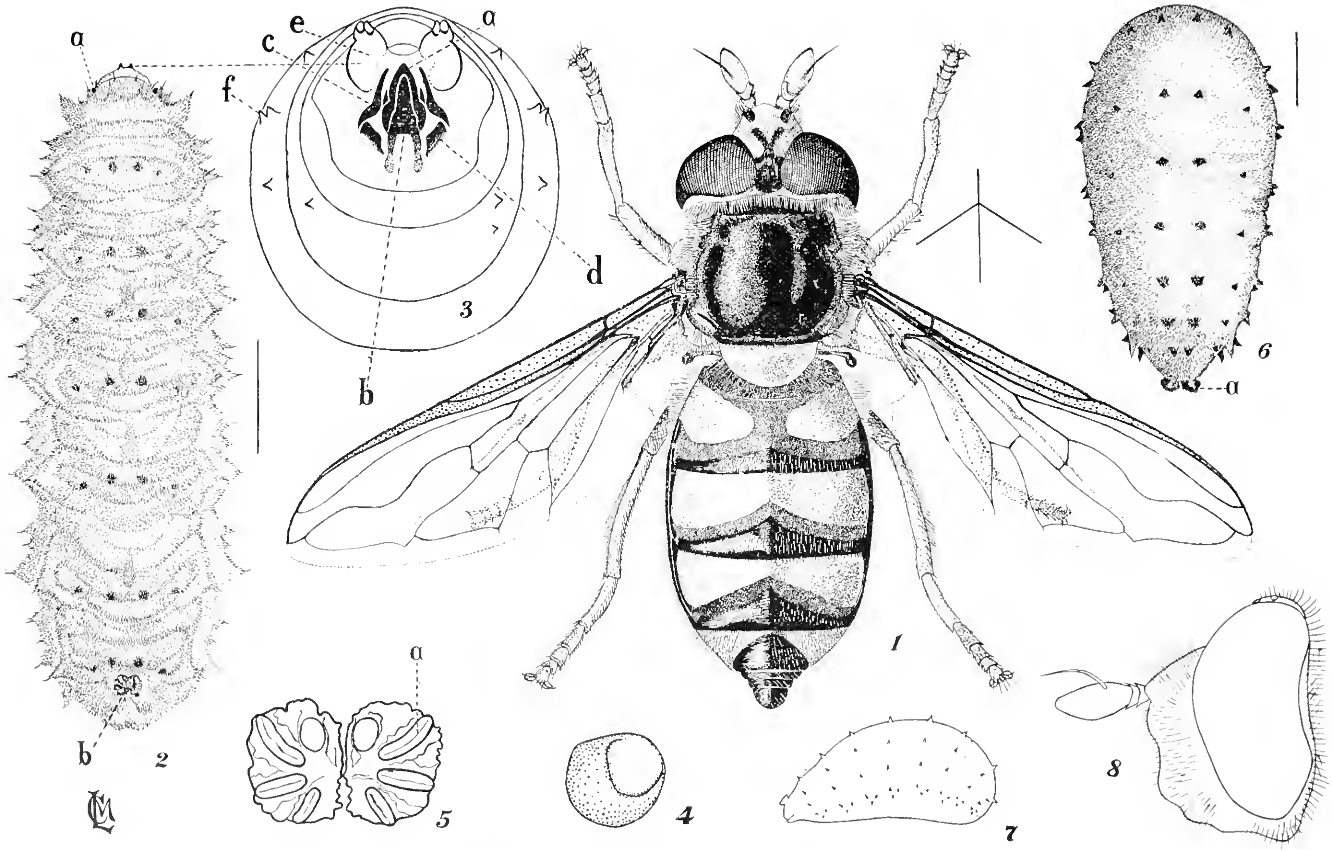
Explanation of Plates XVI and XVII.

Figures 1–8, *Didea fuscipes* Loew.

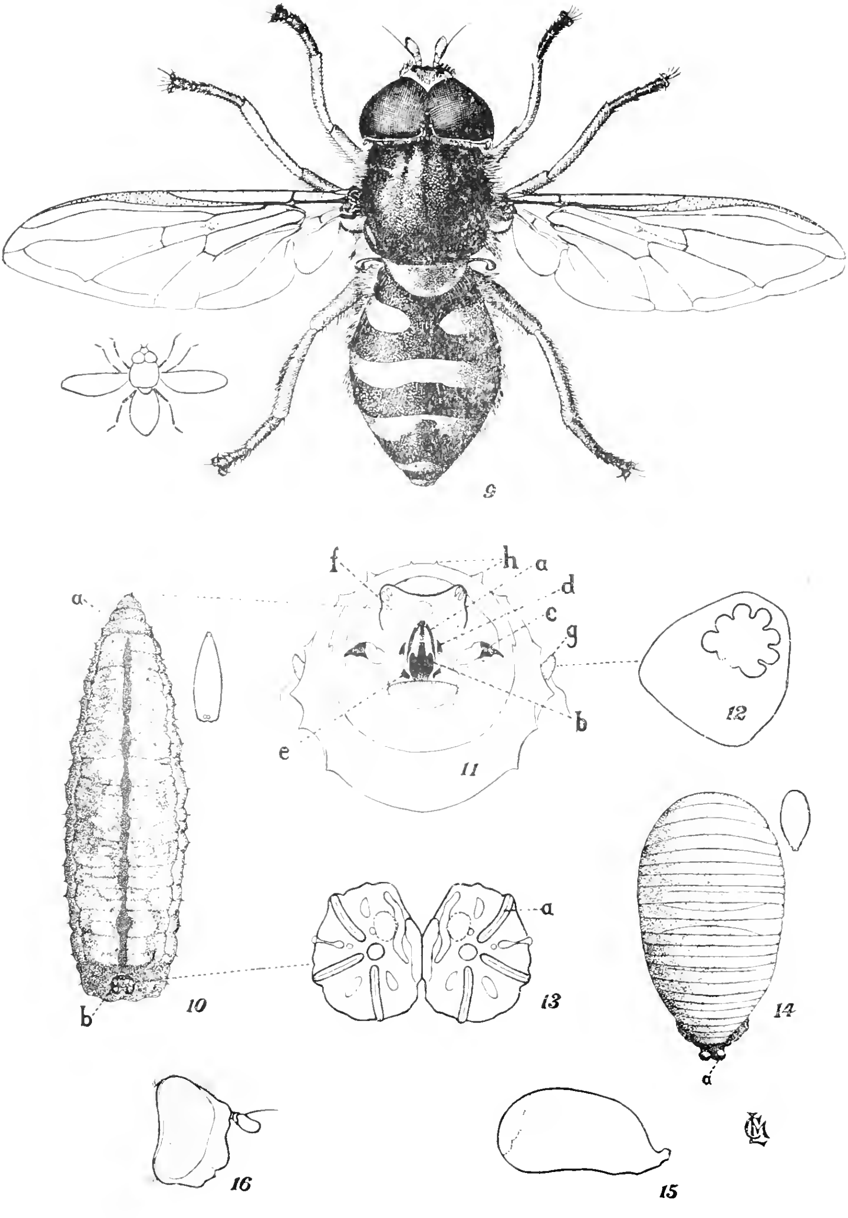
Fig. 1. Adult female x6.
Fig. 2. Larva about six times natural size; *a*, anterior spiracle; *b*, caudal spiracles.
Fig. 3. Antero-ventral view of head and mouth-parts of larva, enlarged; *a*, upper jaw with a small pair of hooklets at the side; *b*, lower jaw; *c* and *d*, lateral hooklets; *e*, antenna; *f*, sense papillae.
Fig. 4. Right anterior spiracle much magnified.
Fig. 5. Posterior breathing organs enlarged; *a*, one of the radiating spiracles.
Fig. 6. Dorsal view of puparium a little more than five times natural size; *a*, caudal spiracles.
Fig. 7. Puparium from the side showing arrangement of spines and line of cleavage for escape of adult.
Fig. 8. Head of male in profile.

Figures 9–16 *Syrphus torvus* Loew.

Fig. 9. Adult male natural size and enlarged.
Fig. 10. Larva natural size and enlarged; *a*, anterior spiracle; *b*, posterior spiracles.
Fig. 11. Antero-ventral view of head and mouth-parts much enlarged; *a* and *b*, upper and lower jaw partially separated; *c*, outer pair of mouth-hooks; *d* and *e*, two inner pairs of mouth-hooklets; *f*, antenna; *g*, anterior spiracle; *h*, sense papillae.
Fig. 12. Anterior spiracle of larva highly magnified.
Fig. 13. Posterior breathing appendages much enlarged; *a*, one of the six caudal spiracles.
Fig. 14. Puparium from above natural size and enlarged; *a*, posterior spiracles.
Fig. 15. Puparium from side showing line of cleavage for escape of adult.
Fig. 16. Head of female in profile.



METCALF on "Species of Syrphidae."



Metcalf on "Species of Syrphidae."

A NOTE ON THE EVAPORATION GRADIENT IN A WOODLOT.*

MALCOLM G. DICKEY.

The subject of evaporation has received much attention within the past few years. Very significant results have been obtained from the standpoint of plant physiology, and ecology as well as meteorology. The question in general, as to its relation to plant societies, has been discussed in connection with an earlier paper on evaporation in a local bog habitat.†

More recently, further work has been carried on in the same habitat to ascertain the evaporation at different heights,‡ and in this connection, it was thought desirable to obtain similar data as to the evaporation gradient in a wooded area.

Owing to the intimate relation between forests, climate, and waterflow, and the important bearing of the subject upon our national conservation policy, forest meteorology has been made the subject of a very careful study. Of especial value are the results of investigations, extending over a number of years, conducted by the German Forest Service. A summary§ of these results reveals the fact that the average evaporation from the ground within woods is about 44% of that within the fields. This reduction of evaporation is accounted for by a greater relative humidity due to lower temperature by shade, breaking of winds, and the protection of the soil litter. The forest, though perhaps less effective in adding moisture to the air than some other types of vegetation formations, gives off a more uniform supply, and continues to do so when elsewhere the saturation deficiency of the air is relatively high.

Although, some general conclusions have been presented as to the vertical gradient of temperature and humidity in the forest, there seem to be no similar data for evaporation. The experiment, discussed here, was undertaken with a view to gaining some light on this phase of the subject. The station selected was located in a woodlot about ten miles north of Columbus. The predominating species is beech, (Fagus americana), with a mixture of white oak, (Quercus alba), maple (Acer Saccharum), and hickory (Hicoria ovata). The stand is fairly dense, and the ground is

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*Contribution from the Botanical Laboratories of Ohio State University, No. 63.

†DICKEY, M. G. Evaporation in bog habitat. OHIO NATURALIST 10: 17–23. 1909.

‡DACHNOWSKI, ALFRED. Vegetation of Cranberry Island (Ohio), and its relation to the substratum, to temperature, and evaporation. Bot. Gaz. 51. 1911.

§HARRINGTON, M. W. Review of forest meteorological observations. In Forest Influences. U. S. Dept. Agr. Div. of Forestry. Bull. 7. 1893.

well shaded. The undergrowth is quite sparse and the soil is covered with a thick layer of leafy litter.

The instruments were the porous cup atmometers similar to those used in previous experiments. A graduated cylinder served the purpose of a reservoir. The cups were loaned by the Carnegie Desert Laboratory at Tucson. Four instruments were installed, one on the ground, at the three-inch level, one at one foot above the soil, another on an upright support at 6 feet, and a fourth resting on a light framework which was raised to a height of thirty-five feet. The instruments were set up on May 28, and weekly readings were begun on May 30, and continued until June 27. At this time, the cups at the one foot, and six foot levels were removed, and returned to the laboratory to be used in other investigations. The remaining instruments were read for three weeks longer. The sixth reading, June 27 to July 12, is for a period of two weeks, and cannot be compared with the other readings. It was the intention to supplement the evaporation readings with the temperature, and humidity data, but unfortunately, the instruments were not available at the time. The data are indicated in the following table:

Table To Show The Evaporation Gradient In A Woodlot.

Date	3 Inches	1 Foot	6 Feet	35 Feet
May 28–30	30.6	29.8	61.6	..
May 30 to June 6	41.5	36.5	77.0	56.0
June 6–13	36.7	38.2	75.9	54.0
June 13–20	91.1	74.7	154.0	126.0
June 20–27	83.1	73.8	140.8	116.0
June 27 to July 12	74.2		.	198.0
July 12–18	54.4		.	88.0

It will be seen by comparison of the readings at the various levels, that the greatest evaporation has occurred in every case at the six foot level, pointing to a decrease in relative humidity from below upwards. The thirty-five foot reading exhibits a modification of this relation, which is due to the moisture given off in the transpiration of the leaves in the forest crown. Contrary to results obtained from similar investigations on Cranberry Island at Buckeye Lake, l. c. 2 and also to the observations of Yapp in an English marsh,* the data do not show a uniform increase of the

*Yapp, R. H. On Stratification in the vegetation of a marsh, and its relations to evaporation, and temperature. Annals of Botany 23:275–320. 1909.

saturation deficiency from the lowest level upward. With the one exception of the reading of June 6–13, which is doubtful in its accuracy, and is further made unreliable on account of heavy rainfall during the week, a greater evaporation has occurred at the one foot level than at the three inch level. Bigelow* has pointed out a similar relation in evaporation from open pans over a sandy desert soil, and explains it by data which show that the temperature at the ground level was from one to two degrees higher than that at ten inches. It may be said, of course, that there is a marked difference between the sandy soil of the desert exposed to the rays of the sun, and the shaded forest floor. However, similar temperature phenomena have been observed in Cranberry bogs of Wisconsin† which have entirely filled the former lake basin. They consequently differ from the bog at Buckeye Lake in that they are not surrounded by an exposed water surface, and have a much lower water table. There is also a distinct difference between the vegetation cover with its high water table in the bog at Buckeye Lake, and the forest litter of our station. Temperature readings at the bog show a much greater range at the three inch level than at one foot or five feet. In the forest, the litter of leaves, and mold acts as an insulator and prevents rapid changes in evaporation, absorption, and radiation from the soil. A much more constant temperature might therefore be expected here, and a more uniformly low evaporating power of the air. Whether this explanation is sufficient to account for the difference pointed out, can not be stated with certainty. Further data are needed to throw light on the subject.

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*Bigelow, F. H. Studies on the phenomena of the evaporation of water over lakes, and reservoirs. Monthly Weather Review, U. S. Dept. Agr. 36:437. 1908.

†Cox, H. J. Frost and temperature conditions in the Cranberry marshes of Wisconsin. U. S. Dept. of Agr. Weather Bureau. Bulletin T.

NOTES ON NEW OHIO AGARICS III.

Wilmer G. Stover.

The following Agarics, collected at Oxford, Ohio, by the writer during 1909 and 1910, have not been previously reported for this state.

Russula ochrophylla Peck. Pileus 5–9 cm., dark red or purplish red, convex, becoming depressed, dry, glabrous, smooth, margin even; flesh white, taste mild. Lamellae ochraceous yellow, dusted with the spores, 6–8 mm. broad, rather close, adnate, interspaces venose. Spores ochraceous, globose, echinulate, 8–9 microns. Stipe 4–7×1–2.5 cm., pale reddish, nearly equal, solid or spongy within. Growing on ground beneath beech trees. August.

Mycena cyaneobasis Peck. Pileus 7–20 mm., conical to subcampanulate, often deep blue or brownish blue when young, usually fading to gray or dingy white when older or in drying, margin striate. Lamellae white or grayish, close, narrow, adnexed. Spores white, subglobose, 6–8 microns. Stipe as much as 11 cm. long, whitish above, pale brownish below, mycelium at the base often blue. The plants were growing in leaf mold in woods. May.

Marasmius semihirtipes Peck. Pileus 1–2 cm., reddish brown becoming alutaceous, glabrous, margin sometimes striate. Lamellae white, narrow, subdistant, adnate. Stipe 3–5 cm.×1 mm., brown or reddish-brown, velvety-tomentose at base to nearly glabrous above. Growing among old leaves and grass. June.

Marasmius scorodonius Fr. Pileus 1–1.5 cm., bay or reddish brown, convex then plane, dry, glabrous, even. Lamellae whitish, narrow, subdistant, interspaces venose. Stipe 2–3 cm. long, slender, horny, dark brown below to pallid at apex, hollow, smooth, polished. Growing in grass at base of pine tree. May be readily recognized by its odor of garlic when fresh. July.

Hard in his mushroom book (p. 144, Fig. 109), gives an excellent illustration of this species. He also describes Russula ochrophylla (p. 187) and Marasmius semhirtipes (p. 145). In none of these cases, however, does he state that the plants were collected in Ohio. It has been thought advisable, therefore, to report them at this time as members of the Ohio flora.

AN OHIO STATION FOR MITREMYCES CINNABARINUS.

Wilmer G. Stover.

During the early part of April, Mr. B. W. Wells brought into the laboratory several specimens of Mitremyces cinnabarinus Desv. which he had collected near Gibsonville, Hocking County. A specimen in the state herbarium shows that the species had been collected near the same place, April 5, 1910, by Prof. R. F. Griggs. The plants were growing in leaf mold in a deep ravine among hemlocks, tulip-trees and undergrowth.

Morgan* refers all the American plants of this genus to M. lutescens Schw., but had no Ohio specimens. Lloyd† states that its range is from Massachusetts to Florida and that it does not extend into the Mississippi basin. Hard‡ gives an illustration but says that while he has seen it growing in the mountains of West Virginia he has never collected it in Ohio. So this is the first the plant has been found in the central West.

*Morgan, A. P. North American Fungi. Jour. Cin. Soc. Nat. Hist. 12:21. 1889.

†Lloyd, C. G. The Genus Mitremyces. Myc. Notes 2:239. 1905.

‡Hard, M. E. Mushrooms, Edible and Otherwise. f. 481, p. 563.

The plant is sometimes known as Calostoma cinnabarinum. The thick rooting base is made up of a number of anastomosing, somewhat gelatinous, cordlike fibers. The fruiting portion of the plant is subglobose and has two coats. The outer coat (exoperidium) is gelatinous when wet and at maturity breaks into pieces and falls away. The inner (endoperidium) is thin and bright red when fresh but soon fades. The mouth is a radiate opening, red on the inner margin and with the border raised. Lining the endoperidium is a special membrane which contains the spores. At maturity, this is said to contract so as to force the spore mass out through the rayed mouth. The spores were shed from all our specimens but are said to be elliptical and 6–8×10–20 microns in size.

This find extends the range of this species and adds to the number of known Ohio Gastromycetae.

TWO UNREPORTED OHIO SPECIES OF UNCINULA.

Wilmer G. Stover.

In the Ohio Naturalist for May, 1910, W. C. O'Kane* listed and described six Ohio species of Uncinula. Recently, in working over material collected at Oxford, Ohio, in 1908 and 1909, the writer has found two other species of that genus. Though doubtless collected by others, this seems to be the first published notice of their occurrence in the state. Specimens have been placed in the State Herbarium.

In the descriptions which follow, the writer has drawn rather freely from Salmon's paper on the Erysiphaceae.†

Uncinula parvula Cooke & Peck. Amphigenous; mycelium evanescent; cleistothecia usually hypophyllous, scattered, 86–122 microns in diameter; appendages 50–160, one-half to three-fourths the diameter of the cleistothecium, simple, colorless, nonseptate, smooth, 3–4 microns wide, apex simply uncinate; asci 5–8, broadly ovate; spores 4–7. On leaves of Celtis occidentalis. Oxford, O. October, 1908.

Uncinula geniculata Gerard. Epiphyllous; mycelium thin, forming definite patches or more or less effused, sometimes evanescent; cleistothecia somewhat gregarious on the patches or scattered, 90–120 microns in diameter; appendages 24–46, one and one-fourth to twice the diameter of the cleistothecium, 3–4 microns wide, some usually abruptly bent or geniculate, simple, colorless,

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*O'Kane, W. C. The Ohio powdery mildews. Ohio Naturalist 10: 166:176. pl. 9–10. 1910.

† Salmon, Ernest S. A monograph of the Erysiphaceae. Memoir Torr. Bot. Club 9:1–292. pl. 1–9. New York. 1900.

nonseptate, smooth or minutely roughened at the base, apex simply uncinate; asci 5–8, broadly ovate; spores 4–6. On leaves of Morus rubra. Oxford, O. October, 1909.

These species may be distinguished from other Ohio species by the narrow, colorless appendages and the 4–7 spored asci; from each other, by the number and length of the appendages.

MEETINGS OF THE BIOLOGICAL CLUB.

Orton Hall, Jan. 16th, 1911.

The meeting was called to order by the president, Dr. Dachnowski. The minutes were read and approved. Dr. William E. Henderson then favored the society with an interesting and instructive address on "Some Recent Theories of Solution and Osmosis and Their Biological Significance. He gave an exposition of the kinetic theory and contrasted it with the recent solution theory of Kahlenberg. The importance of possessing true and definite conceptions concerning osmotic phenomena when attacking physiological problems, was made very evident by the speaker.

After a discussion of the address, the society listened to a report of the American Association meeting at Minneapolis, by Prof. Barrows and a report of the meeting of American physiologists at Yale University by Prof. Seymour. In the short business meeting Prof. T. M. Hills was elected a member of the society. No further business being presented, the society adjourned.

Orton Hall, Feb. 13th, 1911.

The president, Dr. Dachnowski, called the meeting to order. The minutes were read and approved. The first of a series of papers on the history of biology was presented by B. W. Wells. The early history of biological science was covered down to the time of Galen. Mr. B. B. Fulton gave a description of Hocking County as a collecting ground, setting forth the wild and primitive conditions that still obtain in this locality. Mr. J. L. King presented a paper on "Insect Photography," in which he outlined the essentials necessary for success in this special line of work and discussed the methods used by experiment stations in illustrating their entomological bulletins. A number of lantern slides, made from photographs by the speaker, were of much interest.

A short business meeting was held in which Mr. A. R. Shadle was elected a member of the club, after which the society adjourned.

Bertram W. Wells, *Secretary.*

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TABLE OF CONTENTS.

THE KNOWN POLYPORACEAE OF OHIO.[1]

L. O. OVERHOLTS.

The purpose of the present paper is to give a list of the Polyporaceae that have been reported from Ohio. While it is highly probable that some species have been overlooked, yet the list is as complete as could be made from the literature at hand. The floral literature of Ohio is singularly wanting in published lists of our fungi. Perhaps no Basidiomycetes are more difficult to identify than those annual forms of the Polyporaceae which have the white pileus and white context. Even our best mycolygists have trouble in distinguishing them. More than half of the species listed have been collected in the Miami valley by the writer and others connected with the Department of Botany of Miami University.

The nomenclature followed is that of Mr. W. A. Murrill in his monograph of the family. The most generally used synonyms have been added to correlate this paper with other writings on the family. A bibliography of the best American and foreign literature has been appended and an effort has been made to cite as many illustrations as possible. The paper has been prepared with the hope that a number of persons will become sufficiently interested to do collecting in various parts of the state. From such the writer would be glad to receive specimens, and will determine all sent to him for that purpose. Any species not included in this list and those marked as doubtful, are especially wanted for examination.

The writer wishes to express his thanks to all who have aided in the preparation of the paper. Especial thanks are due to the Lloyd Brothers of Cincinnati, for free access to the literature contained in the Lloyd library; to Mr. C. G. Lloyd for his determinations and verifications and for access to his excellent herbarium; to Mr. W. A. Murrill for determinations and verifications and to Dr. Bruce Fink under whose direction the work has been done.

[1] Contributions from the Botanical Laboratory of Miami University. V.

1. **Hydnoporia fuscescens** (Schw.) Murrill, N. Am. Flora 9 : 3. 1907.
Sistotrema fuscescens Schw.
Generally known as Irpex fuscescens Schw. and I. cinnamomeus Fr. This species is wholly resupinate, with a narrow, sterile border. The tubes are at first very short but soon become elongated and irpiciform. The color is a dark yellowish brown. Rather common on dead branches of oak and sugar trees, over the state.

2. **Fuscoporia ferruginosa** (Schrad.) Murrill, N. Am. Flora 9 : 5. 1907.
Boletus ferruginosus Schrad.
Known as Poria ferruginosa (Schrad.) Fr. On dead deciduous wood. Not common.

3. **Fomitiporia obliquiformis** Murrill, N. Am. Flora 9 : 9. 1907.
Collected near Cincinnati on hardwood logs by Morgan and referred to Poria obliquus Pers., a European species. Common.

4. **Fomitiporella inermis** (Ellis & Ev.) Murrill, N. Am. Flora 9 : 13. 1907.
Poria inermis Ellis & Ev.
On deciduous wood. Not common.

5. **Melanoporia nigra** (Berk.) Murrill, N. Am. Flora 9 : 15. 1907.
Polyporus niger Berk.
Characterized by a black hymenium. On oak wood. Probably rare.

6. **Irpiciporus mollis** (Berk. & Curt.) Murrill, Bull. Torr. Club 32 : 471. 1905.
Irpex mollis Berk. & Curt.
Also known as I. crassus Berk. & Curt. On dead deciduous wood. Not common.

7. **Irpiciporus lacteus** (Fr.) Murrill, N. Am. Flora 9 : 15. 1907.
Sistotrema lacteum Fr.
Commonly known as Irpex tulipifera Fr. The most common of all the resupinate forms. It is found on all sorts of dead deciduous branches, frequently with the margin reflexed on both sides.
Illustration: Hard, p. 448, f. 376.

8. **Poronidulus conchifer** (Schw.) Murrill, Bull. Torr. Club 31 : 426. 1904.
Boletus conchifer Schw.
Known as Polyporus conchifer Schw. and as P. virgineus Schw. This species is a very peculiar one. The young plant is a sterile, cup-shaped body about 1 cm. in diameter, varying in color from pure white to dark brown, and marked

with dark concentric rings. The pileus develops from the under side of this cup, which often entirely disappears. The pileus is fan-shaped and generally narrowly attached. The species is easily recognized by the sterile, concentrically zoned, cup shaped structure. Very common on fallen elm branches, from September until winter.

9. **Coriolus versicolor** (L.) Quel. Ench. Fung. 175. 1886.
Boletus versicolor L.

Commonly known as Polyporus versicolor (L.) Fr. The most common and variable of all the Polypori of this region. The writers' specimens include several collections from different localities and no two of them are alike in their combinations of colored zones. It is frequently found encircling small twigs in a spiral manner. It may be found from July until December on all kinds of deciduous wood, in the woods, fields, yards, or along the roadsides. It is frequently found on the lilac and is said to cause a serious disease of that plant. Readily recognized by its thin, coriaceous, multizonate, pileus.

Illustrations: Hard, p. 143, f. 343; Sow. Eng. Fungi, pl. 229

10. **Coriolus hirsutulus** (Schw.) Murrill, Bull. Torr. Club 32 : 643. 1906.
Polyporus hirsutulus Schw.

This plant is closely related to C. versicolor and may be but a variety of that species. On dead deciduous wood. Common.

11. **Coriolus pubescens** (Schum.) Murrill, Bull. Torr. Club 32 : 645. 1906.
Boletus pubescens Schum.

Commonly known as Polyporus pubescens (Schum.) Fr. The entire plant is white or yellowish and the pileus is pubescent but becomes glabrous with age. The hymenium has a silky luster and the walls of the pores are sometimes lacerated. The writer has seen rotten beech logs entirely covered with this fungus. Found from September until winter, on dead wood, especially beech.

Illustration: Hard, p. 410, f. 339.

12. **Coriolus nigromarginatus** (Schw.) Murrill, Bull. Torr. Club 32 : 469. 1906.
Boletus nigromarginatus Schw.

Known as Polyporus hirsutus (Wulf.) Fr. This is a very common species in this region. It is very variable, especially in the character of the pileus. The typical form is rather thick, hirsute, and concentrically zoned, and has a dark colored margin. The hymenium varies in color from

white to brown, but the mouths of the tubes are always regular and have thick dissepiments. Found on all sorts of dead deciduous wood throughout the year.

Illustration: Hard, p. 412, f. 342.

13. **Coriolus biformis** (Klotzsch) Pat. Tax. Hymen. 94. 1900.
Polyporus biformis Klotzsch.

A very constant species found on logs and stumps from September until winter. The hymenium is at first porous but soon becomes lacerate and irpiciform and dries out to a light bay color. It is frequently found much imbricated and laterally confluent, sometimes for several feet along the log. Common.

Illustration: Hard, p. 412, f. 341.

14. **Coriolus prolificans** (Fr.) Murrill, N. Am. Flora 9 : 27. 1907.
Polyporus prolificans Fr.

Also known as P. pergamenus Fr. A variable species quite common on sugar maple, elm, wild cherry, and other deciduous wood. The mouths of the tubes are a beautiful purple color when the plant is young, but they fade out to bay or almost white. The hymenuim becomes irpiciform at an early stage. The purple colored hymenium will serve to identify this species. It is found from July until winter.

Illustration: Hard, p. 415. f. 345.

15. **Coriolellus sepium** (Berk.) Murrill, Bull. Torr. Club 32 : 481. 1905.
Trametes sepium Berk.

Common on fence posts, dry rails, pickets, and old structural timber. The single pilei are never more than 1 cm. in length but they are often found laterally confluent and sometimes almost wholly resupinate. The species can be readily distinguished by its size, habitat, and by the pores, which are very large for such a small plant.

16. **Coriolellus serialis** (Fr.) Murrill, N. Am. Flora 9 : 29. 1907.
Polyporus serialis Fr.

Generally known as Trametes serialis Fr. This species was reported by Morgan, but is probably rare in this state. On deciduous wood.

17. **Tyromyces guttulatus** (Peck) Murrill, N. Am. Flora 9 : 31. 1907.
Polyporus guttulatus Peck.

A doubtful species for Ohio. On coniferous wood.

18. **Tyromyces spraguei** (Berk. & Curt.) Murrill, N. Am. Flora 9 : 33. 1907.
Polyporus spraguei Berk. & Curt.

The writer has collected this species but twice, both collections being taken from beech logs. The whole plant

is white, becoming more or less dingy with age, and is easily identified by its very disagreeable odor. When fresh and growing, the plant is soft and watery, but when dried it becomes exceedingly hard. Found during July and August. Perhaps not common.

19. **Tyromyces caesius** (Schrad.) Murrill, N. Am. Flora 9 : 34. 1907.
Boletus caesius Schrad.
Known as Polyporus caesius (Schrad.) Fr. The pileus is white with a bluish tinge. Probably rare. On dead limbs on the ground.

20. **Tyromyces semipileatus** (Peck) Murrill, N. Am. Flora 9 : 35. 1907.
Polyporus semipileatus Peck.
A doubtful species for Ohio. On deciduous wood.

21. **Tyromyces chioneus** (Fr.) Karst. Rev. Myc. 3[9] : 17. 1881.
Polyporus chioneus Fr.
On deciduous wood. Rare.

22. **Tyromyces lacteus** (Fr.) Murrill, N. Am. Flora 9 : 36. 1907.
Polyporus lacteus Fr.
Probably rare. On beech wood.
Illustration: Fries, Ic. Hymen. pl. 182, f. 1.

23. **Spongipellis unicolor** (Schw.) Murrill, N. Am. Flora 9 : 37. 1907.
Boletus unicolor Schw.
Also known as Polyporus obtusus Berk. Rare. On living maple trees.
Illustrations: Rep. Mo. Bot. Gard. 16: pl. 13-16; Kalchbr. Ic. Hymen. Hung. pl. 34, f. 1.

24. **Spongipellis borealis** (Fr.) Pat. Tax. Hymen. 84. 1900.
Polyporus borealis Fr.
This species is found only on the wood of the spruce tree. Rare in Ohio.

25. **Spongipellis delectans** (Peck) Murrill, N. Am. Flora 9 : 38. 1907.
Polyporus delectans Peck.
On living maple trees. Common.
Illustration: Jour. Cinc. Soc. Nat. Hist. 8 : 99. pl. 1.

26. **Spongipellis galactinus** (Berk.) Pat. Tax. Hymen. 84. 1900.
Polyporus galactinus Berk.
On deciduous wood. Rare.

27. **Bjerkandera adusta** (Willd.) Karst. Medd. Soc. Faun. Fl. Fenn. 5 : 38. 1879.
Boletus adustus Willd.

Known as Polyporus adustus (Willd.) Fr. A very abundant and rather variable species, common on dead deciduous wood, especially of the beech and elm. The pileus is white or pallid and the hymenium is smoke-colored in the young plants, but becomes black in older specimens. It is sometimes found partly resupinate and always much imbricated. From August until winter.

Illustrations: Bull. Herb. Fr. pl. 501, f. 2; Sow. Eng. Fungi pl. 231.

28. **Bjerkandera fumosa** (Pers.) Karst. Medd. Soc. Faun. Fl. Fenn. 5 : 38. 1879.

Boletus fumosus Pers.

Known as Polyporus fumosus (Pers.) Fr. This plant is closely related to the preceding species, but is larger and thicker. The hymenium is lighter in color and the mouths of the tubes are larger and more irregular. On willow and elm. Common.

29. **Bjerkandera puberula** (Berk. & Curt.) Murrill, N. Am. Flora 9 : 41. 1907.

Daedalea puberula Berk. & Curt.

More commonly known as Polyporus puberula Berk. & Curt., and P. fragrans Peck. This plant can be easily recognized by its fragrant odor which persists even after the plant has been dried. The tubes are dark colored; the mouths are large, unequal, and becoming lacerate at maturity. Found most frequently on dead elm wood, from October until December.

30. **Trametes suaveolens** (L.) Fries, Gen. Hymen. 11. 1836.

Boletus suaveolens L.

Also known as T. odora Fr. The willow tree is the only host of this species. Probably rare in Ohio.

Illustrations: Hussey, Ill. Brit. Myc. pl. 43; Sow. Eng. Fungi pl. 228.

31. **Piptoporus suberosus** (L.) Murrill. Jour. Myc. 9 : 94. 1903.

Boletus suberosus L.

Generally known as Polyporus betulinus (Bull.) Fr. Common in the northern part of the state on birch trees.

Illustrations; Bull. Herb. Fr. pl. 312; Sow. Eng. Fungi pl. 212; Hard, p. 408, f. 337.

32. **Porodisculus pendulus** (Schw.) Murrill, N. Am. Flora 9 : 47. 1907.

Peziza pendula Schw.

Also known as Polyporus pocula (Schw.) Berk. & Curt., and as P. cupulaeformis Berk. & Curt. Found on chestnut and sumac bushes. Rare.

33. **Hexagona alveolaris** (DC.) Murrill, Bull. Torr. Club 31 : 327. 1904.

Merulius alveolaris DC.

Also known as Favolus canadensis Klotzsch, and F. europaeus Fr. This is the only species that we have in which the pores radiate outward from the point of attachment of the pileus. The color of the pileus is reddish brown, due to radiating fibrils of that color. The fibrils disappear with age and the pileus becomes pallid and glabrous. The pores are large. The stipe is sometimes well developed, but more often it is short or altogether wanting. When present it is always lateral. The plant is common on dead deciduous wood, especially hickory, and is found from early spring until winter.

34. **Hexagona striatula** (Ellis & Ev.) Murrill, N. Am. Flora 9 : 48. 1907.

Favolus striatulus Ellis & Ev.

Closely resembles H. alveolaris, but distinguished by its smaller pores. On wood of the birch and the beech. Rare.

35. **Polyporus polyporus** (Retz.) Murrill, Bull. Torr. Club 30 : 33. 1904.

Boletus polyporus Retz.

Known as P. brumalis (Pers.) Fr. A common and beautiful species found in the fall, and often persisting far into the winter. The pores are angular, somewhat resembling those of Hexagona, and the pileus is generally umbilicate

Illustrations: Bull. Herb. Fr. pl. 469; Hard, p. 406, f. 335; Atk. Stud. Amer. Fung. f. 186.

36. **Polyporus arcularius** (Batsch) Fries, Syst. Myc. 1 : 342. 1821.

Boletus arcularius Batsch.

This species is closely related to the preceding one, but the pores are larger and more decurrent and the pileus is less umbilicate. It occurs more abundantly in the spring on all kinds of dead deciduous wood.

Illustrations: Micheli, Nov. Pl. Gen. pl. 70, f. 5; Hard, p. 407, f. 336.

37. **Polyporus caudicinus** (Scop.) Murrill, Jour. Myc. 9 : 89. 1903.

Boletus caudicinus Scop.

The same as Polyporus ulmi Paulet, and also P. squamosus (Huds.) Fr. It is a large wound fungus found on elm and maple trees. Not common.

Illustrations: Schaeff. Fung. Bavar. 3: pls. 101, 102; Sow. Engl. Fungi pl. 266; Bull. Herb. Fr. pls. 19, 114.

38. **Polyporus elegans** (Bull.) Fries, Epic. Myc. 440. 1838.
Boletus elegans Bull.

This plant resembles the next species in color and form, but it is very much smaller and has smaller pores. The stipe is black at the base. Abundant in some parts of the state, on dead deciduous wood.

Illustrations: Bull. Herb. Fr. pl. 124; Pat. Tab. Fung. f. 137.

39. **Polyporus fissus** Berk. Lond. Jour. Bot. 6 : 318. 1847.

This plant has been generally known to American mycologists as P. picipes Fr. It is very common from September until December on dead deciduous wood, especially hickory and elm. It is easily recognized by the reddish brown, leathery, pileus, which is depressed or infundibuliform, and by the stipe, which is black at the base. The pileus sometimes reaches a width of 20 cm. or more, and the stipe is eccentric or lateral.

Illustration: Hard, p. 388, f. 319.

40. **Abortiporus distortus** (Schw.) Murrill, Bull. Torr. Club 31 : 422. 1904.
Boletus distortus Schw.

Known as Polyporus distortus Schw. A very variable species found in the late fall around stumps of deciduous trees, especially of the ash. It is normally stipitate and alutaceous in color, but specimens in the writer's collection named by Mr. Murrill are entirely resupinate and pure white in color. Common.

41. **Scutiger radicatus** (Schw.) Murrill, Bull. Torr. Club 30 : 430. 1903.
Polyporus radicatus Schw.

This species is characterized by having a black, rooting stipe. It grows on the ground and is found from September until December. The stipe is central and the tubes are decurrent. The pileus reaches a width of from 5–9 cm. and the stipe is about 10 cm. long. Not common.

Illustrations: Ohio Myc. Bull. 10: f. 46; Hard, p. 400, f. 329.

42. **Grifola poripes** (Fr.) Murrill, Bull. Torr. Club 31 : 335. 1904.
Polyporus poripes Fr.

Also known as P. flavovirens Berk. & Rav. On the ground in woods. Probably rare.

43. **Grifola sumstinei** Murrill, Bull. Torr. Club 31 : 335. 1904.

This plant was collected by Morgan and referred to P. giganteus (Pers.) Fr., and has been known under that name. According to Mr. Murrill, P. giganteus is a European species to which our plant is closely related. It is not

uncommon to find several large clusters of the plant about the base of a stump, especially beech. It resembles G. frondosa (Dicks.) Gray, but the pileoli are fewer in number and much larger. In the fresh specimens the hymenium turns to black when bruised, and this characteristic will identify the species. Found from July until September.

44. **Grifola frondosa** (Dicks.) Gray, Nat. Arr. Brit. Pl. 1 : 643. 1821.

Boletus frondosus Dicks.

Commonly known as Polyporus frondosus (Dicks.) Fr. Resembles the preceding species in form and habit but easily separated. The pileoli are much narrower and more numerous, and are grayish cinerous in color. The plant generally attains a breadth of 20 or 30 cm. and a height of 20 or more cm. Found at the bases of elm and oak stumps during the late fall.

Illustrations: Sow. Eng. Fungi pl. 87; Atk. Stud. Am. Fungi f. 181, 182; McIlv. Am. Fungi pl. 128; Hard, p. 391, f. 321.

45. **Grifola ramosissima** (Scop.) Murrill, Bull. Torr. Club 31 : 336. 1904.

Boletus ramosissimus Scop.

Generally known as Polyporus umbellatus Fr. Found at the base of oak trees. Reported from the southern part of the state, but probably rare.

Illustrations: Schaeff. Fung. Bavar. pl. 111; Atk. Stud. Am. Fungi f. 178; Hard, p. 390, f. 320.

46. **Grifola berkeleyii** (Fr.) Murrill, Bull. Torr. Club 31 : 337. 1904.

Polyporus berkeleyii Fr.

The same as P. anax Berk. "Nobilissimus inter-omnes mihi cognitos Polyporus," to quote from Fries. A rather common species found around oak or ash stumps in August and September. It has globose, echinulate, spores which will identify it, as no other closely related species has such. Capt. McIlvaine cites an instance of a plant of this species being found near Boston several years ago, which "was fully four feet high and from two to three feet broad."[2]

Illustration: Hard, p. 393, f. 323.

47. **Pycnoporus cinnabarinus** (Jacq.) Karst. Rev. Myc. 3^9 : 18. 1891.

Boletus cinnabarinus Jacq.

Commonly known as Polyporus cinnabarinus (Jacq.) Fr. This species is easily identified by its color, which is a cinna-

[2] One Thousand American Fungi, p. 484.

bar red both on the pileus and on the hymenium, although the pileus fades out with age. The fungus is quite common on dead wood of the wild cherry, sugar, etc. From August until December.

Illustrations: Jacq. Fl. Austr. pl. 304; Bull. Herb. Fr. pl. 501, f. 1; Hard, p. 409, f. 338.

48. **Aurantiporus pilotae** (Schw.) Murrill, Bull. Torr. Club 32 : 487. 1905.

Polyporus pilotae Schw.

A very rare plant in this state and is said to grow on oak and chestnut wood.

49. **Laetiporus speciosus** (Batt.) Murrill, Bull. Torr. Club 31 : 607. 1904.

Agaricus speciosus Batt.

Known as Polyporus sulphurus (Bull.) Fr. Polyporus cincinnatus Morg. is the same plant. Easily recognized by the color of the hymenium, which is a bright sulphur yellow. The pileus varies in color from yellow to reddish orange and specimens in the writer's collection are faded to almost white. It frequently occurs as a parasite and is said to cause much damage to forest trees. It is always found much imbricated and often substipitate. Common from August until November, on stumps and trunks of oak, locust, etc.

Illustrations: Batt. Fung. Hist. pl. 34, f. B; Bull. Herb. Fr. pl. 429; Gibson, pl. 26; Hard, p. 397, f. 326.

50. **Cerrenella farinacea** (Fr.) Murrill, N. Am. Flora 9 : 74. 1907.

Irpex farinaceus Fr.

Ohio is almost out of the range of this species, which is more common farther south. On dead deciduous wood.

51. **Coriolopsis rigida** (Berk. & Mont.) Murrill, N. Am. Flora 9 : 75. 1907.

Trametes rigida Berk. & Mont.

A semi-resupinate form found on dead wood, especially of the sugar-maple. The pileus is never more than 2 cm. in width, and is often entirely wanting. The hymenium is wood-colored. Common.

52. **Funalia stuppea** (Berk.) Murrill. Bull. Torr. Club 32 : 356. 1905.

Trametes stuppeus Berk.

Easily recognized by the very villous pileus, the dark colored hymenium, and the large angular pores, which are about 1 mm. in diameter. Most frequently found on poplar and cottonwood logs, but also on willow. Probably rare, at least in the southern part of the state.

53. **Hapalopilus rutilans** (Pers.) Murrill, Bull. Torr. Club 31: 416. 1904.

Boletus rutilans Pers.

The same as Polyporus nidulans Fr. Not common. On dead deciduous wood.

54. **Hapalopilus gilvus** (Schw.) Murrill, Bull. Torr. Club 31 : 418. 1904.

Boletus gilvus Schw.

Known as Polyporus gilvus Schw. Common on dead deciduous wood, especially beech. In very young specimens the pileus is often covered with a purplish tomentum which disappears with age. The pileus is generally rough and of a tawny color. The hymenium is darker in color than the pileus. The plant is generally found imbricated but is frequently found singly.

55. **Ischnoderma fuliginosum** (Scop.) Murrill, Bull. Torr. Club 31 : 606. 1904.

Boletus fuliginosus Scop.

Known as Polyporus resinous Schrad. A handsome fungus with dark pileus. When young the plant is soft and fleshy and filled with a colored juice. As the plant gets older the pileus becomes harder. The pore surface is pallid and turns immediately to brown when touched. The pores are very minute. Common from October until December on dead deciduous logs.

Illustrations: Fries, Ic. Hymen. pl. 483, f. 2; Hard, p. 403, f. 331.

56. **Antrodia mollis** (Sommerf.) Karst. Medd. Soc. Faun. Fl. Fenn. 5 : 40. 1879.

Daedalea mollis Sommerf.

Known as Trametes mollis (Sommerf.) Fr. and as T. cervinus Pers. A sessile or resupinate form on dead wood. Not common.

57. **Inonotus hirsutus** (Scop.) Murrill, Bull. Torr. Club 31 : 594. 1904.

Boletus hirsutus Scop.

Reported by Morgan as Polyporus endocrocinus Berk. Also known as P. hispidus (Bull.) Fr. On trunks of deciduous trees. Rare in Ohio.

Illustrations: Bull. Herb. Fr. pl. 210; Sow. Eng. Fungi pl. 345.

58. **Inonotus dryophilus** (Berk.) Murrill, Bull. Torr. Club 31: 597. 1904.

Polyporus dryophilus Berk.

Very rare. Always found on oak wood.

59. **Inonotus perplexus** (Peck) Murrill, Bull. Torr. Club 31 : 596. 1904.

Polyporus perplexus Peck.

This species is a very variable one. When fresh and growing it is spongy and tomentose, but becomes quite glabrous with age. The mouths of the pores are grayish brown, becoming darker. A common fungus on dead wood, especially of the beech, from September until December.

Illustration: Hard, p. 401, f. 330.

60. **Inonotus radiatus** (Sow.) Karst. Rev. Myc. 3 : 19. 1881.

Boletus radiatus Sow.

Known as Polyporus radiatus (Sow.) Fr. Found on the alder. Rare.

61. **Coltricia cinnamomea** (Jacq.) Murrill, Bull. Torr. Club 31 : 343. 1904.

Boletus cinnamomeus Jacq.

The same as Polyporus subsericeus Peck and Polystictus cinnamomeus Jacq. The distinguishing characteristic of this species is its thin, shining pileus, bright cinnamon in color and marked by silky striations. It is a small plant, with a slender, central stipe, and usually grows on mossy ground. The pileus is always somewhat depressed at the center, and sometimes very much so. A rare plant as far as the writer's collecting goes, but it is small and easily overlooked.

Illustrations: Atk. Stud. Am. Fungi f. 187; Hard, f. 344; Jacq. Coll. pl. 2; Myc. Notes f. 200.

62. **Coltricia perennis** (L.) Murrill, Jour. Myc. 9 : 91. 1903.

Boletus perennis L.

Known as Polyporus perennis (L.) Fr. Very similar to the preceding species but lacks its shining zones. Probably rare. On ground in woods.

Illustrations: Sow. Eng. Fungi pl. 192; Bull. Herb. Fr. pl. 28.

63. **Coltricia focicola** (Berk. & Curt.) Murrill. N. Am. Flora 9 : 92. 1907.

Polyporus focicola Berk. & Curt.

Known as Polyporus connatus Schw. On ground in woods. Not common.

64. **Coltricia obesa** (Ellis & Ev.) Murrill, Bull. Torr. Club 31 : 346. 1904.

Polystictus obesus Ellis & Ev.

This fungus was collected in the Miami Valley by Lea and referred to P. montagnei Fr. by him. Rare. On ground in woods.

65. **Fomes roseus** (Alb. & Schw.) Cooke, Grevillea 14 : 21. 1885.
Boletus roseus Alb. & Schw.

Known as Fomes carneus Cooke. On dead wood not common.

Illustrations: Nees, Nova Acta Acad. Leop. Carol. 13: pl. 3; Fries, Ic. Hymen. pl. 186, f. 1.

66. **Fomes fraxineus** (Bull.) Cooke, Grevillea 14 : 21. 1885.
Boletus fraxineus Bull.

A rare species for this country, although a few good collections have been made, all of which are annual. Generally found on ash trees.

Illustration: Bull. Herb. Fr. 10: pl. 433, f. 2.

67. **Fomes ohiensis** (Berk.) Murrill, Bull. Torr. Club 30 : 230. 1903.
Trametes ohiensis Berk.

This little fungus (very small for the genus Fomes) is found abundantly on fence posts, rails, pickets, dead spots on certain deciduous trees, and on old structural timber. The pileus becomes black only at the base, and the tubes are longer than in F. scutellatus (Schw.) Cooke with which it is often confused. The hymenium is white and the walls of the tubes are almost as thick as the diameter of the mouths.

68. **Fomes scutellatus** (Schw.) Cooke, Grevillea 14 : 19. 1885.
Polyporus scutellatus Schw.

Rare, growing only on the alder in this state.

69. **Fomes fraxinophilus** (Peck) Sacc. Syll. Fung. 6 : 172. 1888.
Polyporus fraxinophilus Peck.

This species is found on species of Fraxinus and is a wound parasite. It grows to be very large, specimens having been brought in which were 30 cm. across. It is perennial and most commonly grows from 30 to 40 feet above the ground. The pileus is at first white but becomes black and rimose with age. Common.

Illustrations: Bull. U. S. Dept. Agr. Pl. Ind. 32: pl. 2. 1903; Hard, p. 421, f. 350.

70. **Fomes populinus** (Schum.) Cooke, Grevillea 14 : 20. 1885.
Boletus populinus Schum.

Known as F. connatus Gill. Always found at the bases of sugar trees, between the roots, and generally covered with moss. Common.

Illustrations: Fries, Ic. Hymen. pl. 185, f. 2; Gill. Champ. Fr. pl. 466.

71. **Pyropolyporus igniarius** (L.) Murrill, Bull. Torr. Club 30 : 110. 1903.

Boletus igniarius L.

Fomes nigricans Fr. is the same plant. A large perennial fungus with a woody pileus which becomes black and rimose with age. Occurring on deciduous trees, but not common.

Illustration: Gill. Champ. Fr. pl. 290.

72. **Pyropolyporus fulvus** (Scop.) Murrill, Bull. Torr. Club 30 : 112. 1903.

Boletus fulvus Scop.

Listed by Morgan as P. supinus Fr. Also known as Fomes fulvus (Scop.) Gill. and F. pomaceus Pers. Found only on plum trees. Frequent.

73. **Pyropolyporus everhartii** (Ellis & Gall.) Murrill. Bull. Torr. Club 30 : 114.

Mucronoporus everhartii Ellis & Gall.

Known as Fomes everhartii Ellis & Gall. Generally found on oak wood. Not common.

Illustration: Jour. Myc. 5: pl. 12. 1889.

74. **Pyropolyporus robiniae** Murrill, Bull. Torr. Club 30 : 114. 1903.

Generally known to American mycologists as Fomes rimosus Berk. A wound parasite found only on living trunks of Robinia pseudacacia. It is quite a large fungus, and the pileus becomes black and rimose with age. The hymenium is tawny. Common.

Illustrations: Rep. Mo. Bot. Gard. 12: pl. 1-3; Hard, p. 418, f. 347.

75. **Pyropolyporus conchatus** (Pers.) Murrill, Bull. Torr. Club 30 : 117. 1903.

Boletus conchatus Pers.

Commonly known as Fomes conchatus (Pers.) Fr. This species is a very variable one, generally found wholly resupinate on the under side of dead deciduous logs, especially the oak. It is perennial and the hymenium is a dark chestnut brown. In the pileate forms the pileus is concentrically zoned and black. Common.

Illustration: Fries, Ic. Hymen. pl. 185, f. 2.

76. **Porodaedalea pini** (Thore) Murrill, Bull. Torr. Club 32 : 367. 1905.

Boletus pini Thore.

Commonly known as Trametes pini Fr. A parasitic, perennial fungus, easily identified by the black, ungulate surface and yellowish brown hymenium, with more or less labyrinthiform pores.

77. **Globifomes graveolens** (Schw.) Murrill, Bull. Torr. Club 31 : 424. 1904.

Boletus graveolens Schw.

Known as Polyporus conglobatus Berk. and Fomes graveolens (Schw.) Cooke. A very peculiar fungus, forming an imbricated, cylindrical mass of overlapping pileoli. Generally found on beech logs. The color while growing is a rusty brown, but the old plants become black. Found in September and October. Not common. Commonly called "sweet knot" on account of its fragrant odor. The writer's specimens were collected in a growing condition, but no odor was noticeable.

Illustrations: Ohio Myc. Bull. 9: f. 41; Hard, p. 405, f. 334.

78. **Elfvingia fomentaria** (L.) Murrill, Bull. Torr. Club 30 : 298. 1903.

Boletus fomentarius L.

Commonly known as Fomes fomentarius (L.) Fr. On beech and birch. Rare.

Illustrations: Gill. Champ. Fr. pl. 467; Sow Eng. Fungi pl. 133.

79. **Elfvingia lobata** (Schw.) Murrill, Bull. Torr. Club 30 : 299. 1903.

Fomes lobatus Schw.

Known as Fomes reniformis Morg. An annual fungus, which, however, frequently revives, but the second year's growth comes out below that of the previous year. This point distinguishes it from the next species, which it resembles. Rather common about the bases of old stumps.

80. **Elfvingia megaloma** (Lev.) Murrill, Bull. Torr. Club 30 : 300. 1903.

Polyporus megaloma Lev.

Known as Fomes leucophaeus Mont. and incorrectly called Polyporus applanatus Pers. It is perennial and in point of size is perhaps the largest of all that are found in the state. A specimen collected at Oxford, Ohio, in June of 1909 measures 50x30x30 cm. It frequently grows imbricated, but more often it is found single. Very common throughout the year on all kinds of dead deciduous logs and stumps, and frequently on living trees. It is generally found near the ground, but the writer has seen specimens on a living sugar tree, 40 feet above the ground. At certain seasons of the year the pileus is covered with the brown conidia which are produced on the upper surface. When fresh, the hymenium turns brown when rubbed.

81. **Ganoderma curtisii** (B.) Murrill, Bull. Torr. Club 29 : 602. 1902.
Polyporus curtisii Berk.
Closely related to the next species, but probably rare in this state. Said to grow on ash and maple wood.

82. **Ganoderma sessile** Murrill, Bull. Torr. Club 29 : 604. 1902.
This species has always been known to American collectors as Polyporus lucidus (Leys) Fr. Collectors should have no trouble in identifying it, as it is the only species with a varnished pileus that is at all common here. It occurs both with and without a stipe, but when the stipe is present it is always lateral. Common at the bases of stumps of different deciduous trees.
Illustrations: Atk. Stud. Am. Fung. p. 192, pl. 72; Hard. p. 404, f. 332.

83. **Cerrena unicolor** (Bull.) Murrill, Jour. Myc. 9 : 91. 1903.
Boletus unicolor Bull.
Known as Daedalea unicolor (Bull.) Fr. The collector who finds this plant for the first time is very likely to decide immediately that it belongs to the genus Coriolus, as the thin, leathery, pileus and irpiciform hymenium would indicate. But the hymenium is at first plainly labyrinthiform, and only becomes irpiciform with age. The hymenium is at first white but later takes on a darker color. The pileus is densely strigose-villous, multi-zonate, and frequently covered with a green alga. Common on all kinds of dead deciduous wood. The writer frequently finds specimens which have continued their growth the second year from the margin of the first year's growth.
Illustrations: Bull. Herb. Fr. pl. 408, 501; Bolt. Hist. Fung. app. pl. 16; Sow. Eng. Fungi pl. 325.

84. **Daedalea quercina** (L.) Pers. Syn. 500. 1801.
Agaricus quercinus L.
On dead oak wood. Said to be common in some parts of the state.
Illustrations: Sow. Eng. Fungi pl. 181.; Bull. Herb. Fr. pl. 352; Hard, p. 428, f. 357.

85. **Daedalea confragosa** (Bolt.) Pers. Syn. 500. 1801.
Boletus confragosus Bolt.
Trametes rubescens Fr. is a thin form of this plant. It is the only species of the genus that is at all common here. Various conditions of the hymenium are found, grading from strictly poroid to labyrinthiform and lamellate, sometimes all stages being found in one plant. The hymenium changes from white to reddish brown when touched. Found from August until December, on dead willow wood.
Illustrations: Bolt. Halifax Fung. Suppl. pl. 160; Alb. & Schw. Consp. Fung. pl. 11, f. 2; Hard, p. 429, f. 358.

86. **Daedalea aesculi** (Schum.) Murrill, Bull. Torr. Club 32 : 89. 1905.

Boletus aesculi Schum.

Commonly known as D. ambigua Berk. Very common in some parts of the state. The whole plant is pure white. On dead deciduous wood.

Illustration: Hard, p. 427, f. 355–356.

87. **Lenzites betulina** (L.) Fries, Epicr. Myc. 405. 1838.

Agaricus betulinus L.

Because of its lamellate hymenium, this plant is often given under the white spored Agarics. It is very common on dead deciduous wood. The lamella are thick and often anastamose. The pileus is multi-zonate and variously colored. May be found at any time of the year, on all kinds of deciduous wood.

Illustrations: Sow. Eng. Fungi pl. 182; Hard, p. 230, 231, f. 184, 185.

88. **Gloeophyllum trabeum** (Pers.) Murrill, Bull. Torr. Club 31 : 605. 1904.

Agaricus trabeus Pers.

Known as Lenzites vialis Peck. A common species over the state, occurring on dead wood.

Illustration: Sow. Eng. Fungi pl. 182.

89. **Gloeophyllum hirsutum** (Schaeff.) Murrill, Jour. Myc. 9 : 94. 1903.

Agaricus hirsutus Schaeff.

Same as Lenzites saeparia Fr. Found only on pine wood. Not common.

Illustration: Sow. Eng. Fungi pl. 418.

90. **Cycloporus greenei** (Berk.) Murrill, Bull. Torr. Club 31: 423. 1904.

Cyclomyces greenei Berk.

A curious fungus with the pores arranged in concentric circles. Grows on the ground. Rare.

Illustrations: Lond. Jour. Bot. 4: pl. 11; Hard, p. 430, 431, f. 360, 361.

Besides the above species, there are a few which have not been provided for in Mr. Murrill's classification. His work on the species with the gelatinous hymenium and on the Porias which have a white hymenophore, has not yet been published. The following is a list of those recorded from Ohio:

91. **Fistulina hepatica** Fr. Not common.
92. **Fistulina pallida** Berk. & Rav. Rare. On chestnut and oak wood.
93. **Polyporus rhipidium** Berk. Not common.

94. **Polyporus dichrous** Fr. Common. Has a reddish purple hymenium.
95. **Poria purpurea** Fr. Not common.
96. **Poria attenuatus** Peck. Not common.
97. **Poria rufa** Schrad. Rare.
98. **Poria xantholoma** Schw. Perhaps common.
99. **Poria contiguus** (Pers.) Fr. Common.
100. **Poria unita** Pers.
101. **Poria bombycina** Fr.
102. **Poria cinerea** Schw.
103. **Poria vulgaris** Fr. The same as P. pulchella Schw.
104. **Poria obducens** Pers.
105. **Poria mollusens** Fr.
106. **Poria viridans** Berk. & Br.
107. **Poria gordoniensis** Berk. & Br.
108. **Poria vaporarius** Fr.
109. **Poria tenuis** Schw.
110. **Poria callosa** Fr.
111. **Poria spissus** Schw.
112. **Merulius tremellosus** Schrad. Common.
113. **Merulius rubellus** Peck. Common.
114. **Merulius himantioides** Fr.
115. **Merulius corium** Fr.
116. **Merulius molluscus** Fr.
117. **Merulius porinoides** Fr.
118. **Merulius lachrymans** Fr.

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TWO SPECIES OF DIPTERA OF THE GENUS DROSOPHILA.

H. R. Niswonger.

The minute flies of the genus Drosophila are especially abundant about decomposing vegetables, and fermented fruit, around cider refuse, wine vats, vinegar, etc.; attracted to these substances for food and as places of oviposition, since the larvae live in decaying organic matter. The two species under consideration are Drosophila buskii Coq. and Drosophila funebris Fab.

The species of this genus are of a dusty red, yellow or black, and somewhat plump appearance. The feathered or comb-like arista of the antennae, the distinct oral vibrissae, and the peculiar venation of the wings are especially characteristic. The arista is plumose or feathered on both sides mostly on the upper from the middle on. The wings are longer than the abdomen, the distance between the anterior and posterior cross-veins less than the third segment of the fourth longitudinal vein. The second basal cell is united with the discal cell and consequently seeming to be absent. The costa reaches to the fourth longitudinal vein.

Drosophila busckii Coq. This species is recorded as reared from rotten potatoes and from the burrows of "Chion cinctus" one of the long-horned beetles whose larva tunnel in the solid wood of hickory trees. The writer succeeded in having this species oviposit in decayed fruit, but was unable to carry the life history any farther than the egg stage. Decaying vegetables seem to be the chief breeding places. The exact period of the different stages was not determined, but about two weeks are required for the development from the egg to the adult. The eggs are laid in the decaying matter and the entire larval period is passed within this. About the time the larva enters the pupal stage it leaves the decaying material and pupates near by within the old larval skin. The adult emerges in a few days.

Description of insect: Egg, Fig. 1e. The egg is elongated in form and white in color. Near the cephalic end are slender appendages varying in number from three to five. The egg with appendages is about five-tenths (.5) millimeters in length, and the whole surface is ornamented with a net-like pattern.

Larva. Fig. 1d. The larva is a slender white maggot and when full grown measures about four (4) millimeters in length. It is widest near the middle and tapering toward each end, more toward the cephalic end than the caudal. The main trachael trunks are visible, the cephalic spiracle prominent, compound, consisting of several, usually eight divisions, each division opening separately, Fig. 1f. This compound spiracle may be exerted quite a distance or may be withdrawn into the prothoracic segment. Two caudal spiracles project prominently backward. Caudal segment

truncated bearing dorsad a pair of blunt tubercles and a longer pair situated laterad of the caudal spiracles. The dorsal surface of the abdomen bears six rows of tubercles, segmentally arranged, the two outer rows larger than the other four which are very small; laterad of each outer row is a row of small tubercles. The mouth is armed with two strong black curved parallel hooks which are used in rasping the food. The black oral hooks and the two pair of spiracles are visible to the naked eye but their structure can only be made out by the aid of the microscope.

Pupa. Fig. 1c. The pupa is shorter than the larva, about three and seven-tenths (3.7) millimeters in length but much thicker. The cephalic and caudal spiracles projecting, the former very conspicuously; the two larger rows of tubercles visible. There is a large concavity on the dorsal surface of the cephalic end.

Adult. Fig. 1. Head and thorax yellow, with black bristles and hairs; two rusty yellow frontal vittae; two pairs of outer vertical bristles; three pair of orbital bristles, the anterior pair directed forward the others backward; a few short bristly hairs at the base of each antennae. First two joints of antennae dark rusty yellow, the third dark brown. Fig. 1b. Black ocellar dot. Eyes pale red; mouth parts yellow. Dorsal surface of abdomen marked sometimes by five black vittae, usually four, of which the medium one is forked posteriorly; the pleuron marked by three black vittae. Abdomen black, a median yellow vittae. the first segment light rusty yellow, the others marked anteriorly by yellow cross bands; legs yellow; wings hyaline, the costa reaching to the fourth longitudinal vein.

Drosophila funebris Fab. This species is common to Europe and North America and its habits resemble the species Drosophila ampelophila, described by Comstock. It is recorded as breeding in rotten cherries and in the waste of pressed olives.

Adult. Fig. 2. Thorax rusty yellow, a little glossy, marked with dark spots giving it a brownish appearance; abdomen broad, black, a median pale yellow vittae, the first segment usually black the others marked at outer angles by yellow cross bands and a pale yellow line, often whitish, at the posterior border; under side of face yellow; front broad dark rusty yellow, above the antennae lighter; a black ocellar dot; three pair of orbital bristles, the two bristles composing the anterior pair directed forward, the others backward; pair of ocellar bristles; two pairs of outer vertical bristles, pair of median vertical bristles; antennae reddish yellow, third segment the longest, often dark; arista long, for a distance plumose, the under side of the basal part naked; legs pale yellow often becoming darker; wings of a very pale yellow tint, veins rusty yellow; the distance between the two cross veins somewhat smaller than the ultimate segment of the fourth longitudinal vein.

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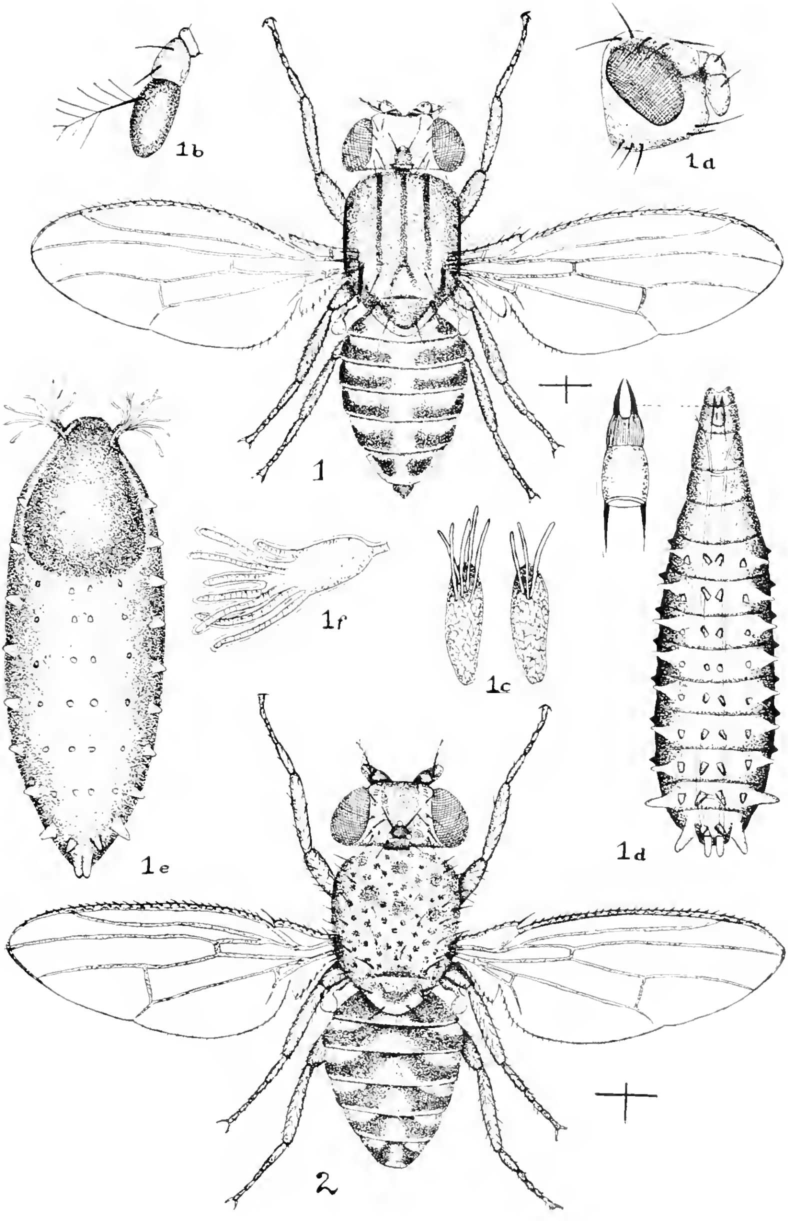
Explanation of Plate XVIII.

Fig. 1. Drosophila busckii.

- 1a. Head from the side.
- 1b. Antenna enlarged.
- 1c. Eggs with appendages.
- 1d. Full grown larva-dorsal view.
- 1e. Pupa—dorsal view.
- 1f. Compound spiracle, magnified.

Fig .2. Drosophila funebris.



NISWONGER on "Two Species of Diptera of the Genus Drosophila.

POLLINATION NOTES FROM THE CEDAR POINT REGION.

WM. BEMBOWER.

An extremely interesting phase of the study of Ecology in the vicinity of the Ohio State Lake Laboratory is that of pollination. There are various reasons for this: the plants range from purely Hydrophytic to quite Xerophytic, with numerous intermediate groups, and there are represented self-pollinated as well as all of the various classes of cross-pollinated plants.

Another interesting feature is that during the summer term only one specimen of the Honey Bee (Apis mellifica) was taken on Cedar Point. The supposition is that there are no colonies of the bees on the Point and that the occasional visitor came over from the mainland, three miles distant. A common pollinator is thus eliminated from the Cedar Point list.

Of the self-pollinated types of flowers, as found on Cedar Point, there are the cleistogamous flowers of the violet which are fertilized before the buds open, as well as the various types in which self-pollination is inevitable from the situation of the stigmatic surface below the discharging anthers.

In the cross-pollinated types we find most of the different general classes represented; as, wind, pollinated, insect-pollinated, bird-pollinated, snail-pollinated, and water-pollinated flowers.

The wind-pollinated flowers are easily recognized by their inconspicuousness; by the absence of any particular attraction for animals, such as odors, food, etc.; and by the abundance of pollen. The water-pollinated type is represented by the Eel Grass (Vallisneria spiralis) in the coves on the south shore of the Point.

Of the bird-pollinated plants only a few observations were made. The Humming Bird was observed to visit the Pickerel Weed (Pontederia cordata) and the Buttonbush (Cephalanthus occidentalis) about the 20th of July, at about which time this bird is recorded to put in its appearance each year on the Point. This is presumably after the nesting season, after the young have flown from the nest, and as in the two plants mentioned seeds which were approaching maturity were observed previous to this date the conclusion is that the bird may aid in pollination but is not essential to it.

Turning now to the Entomophilus or insect-pollinated plants which comprise the largest class on the Point we find many adaptations between plants and insects. Many ingenious theories have been devised to explain why certain insects are attracted to certain flowers and considerable experimentation has been carried on in attempts to prove these theories. For the most complete work on this subject we have referred to a three-volume work by Knuth.[1] Quotations will be made from this work having ref-

[1] Knuth, Dr. Paul. Handbook of Flower Pollination. 3 vols. Translated by J. R. Ainsworth Davis. Oxford. 1906–1909.

erence to various structures of some of the Cedar Point plants upon which insect-visitors were collected. Most of the insects observed were members of the following orders, namely: Diptera, Lepidoptera, Coleoptera, and Hymenoptera.

We will now take up a consideration of some of the characteristics of a few of the summer-blooming plants of Cedar Point and note some of their insect-visitors. These studies were carried on under the direction of Mr. O. E. Jennings, Instructor in Ecology during the term of 1910.

Nymphaeaceae (Water Lily Family).

"The large floating flowers are protected from creeping animals by their aquatic habitat, and are only accessible to flying insects. The inner side of the sepals is colored like the petals, so that both whorls are conspicuous. A more or less distinct odor of honey also serves as a further attraction to insects."[2]

Castalia tuberosa. "The faintly odorous large white flowers which open in the morning and close towards evening are homogamous, according to observations. Kerner states that the stigmatic papillae are mature at the beginning of antithesis, remaining receptive for several days. The anthers dehisce a day —or rarely a few days—later. The filaments bend into the form of a sickle, so as to bring the anthers above the stigmas, which spread out into a plate-like surface so that self-pollination must result from the falling of pollen. Insect visitors may effect either cross- or self-pollination, but they are few in number."[3]

Visitors: *Diptera: Eristalis flavipes.*

Nymphaea advena. This water lily also may be self- or cross-pollinated. The visitors taken are as follows:

Visitors: *Diptera; Mesograpta marginata; Coleoptera; Donacia pusilla.*

Nelumbo lutea. Sprengel says: "The increased size and yellow color of the upper surface of the sepals have taken on the function of the corolla, and the under sides of the petals secrete honey" which serves to attract insects.

Visitors: *Diptera; Allograpta obliqua, Eristalis tenax, Mesograpta marginata; Coleoptera; Disonyca pennsylvanica, Diabrotica 12-punctata; Hymenoptera; Microbembex monodonta, Agapostemon radiatus.*

Malvaceae (Mallow Family).

Hibiscus moscheutos. This plant is quite conspicuous on the edge of the marsh and with its pink or whitish color and its abundance of pollen proves attractive to certain insects. Insect visitors are essential to pollination since the stigma is slightly above

[2] Op. cit., II. 59.
[3] Op. cit., II. 59.

and to one side of the anthers. The stigmatic surface furnishes a convenient lighting place for insect visitors when they first arrive, thus affecting cross-pollination.

Visitors: *Diptera; Phthiria sulphurea, Lucilia caesar; Coleoptera; Disonycha pennsylvanica; Hymenoptera; Agapostemon splendens, Monarda maculata.* A *Bombus*, probably *B. americana*, was observed but not taken.

Rosaceae (Rose Family).

Rosa carolina. A not uncommon plant around the edge of the marsh or around ponds and swampy places.

Visitors: *Diptera; Eristalis americana, Eristalis tenax, Allograpta obliqua; Hymenoptera; Agapostemon radiatus.*

Cactaceae (Cactus Family).

Opuntia rafinesquii. This cactus, a true Xerophyte, has a yellow flower that attracts many insects which may effect either self- or cross-pollination. The filaments are sensitive to mechanical stimulation. They incline inwards on being touched by insects, or even spontaneously, and thickly cover the stigmas with pollen. Autogamy thus regularly takes place and is always effective.[4]

In observing the opening of a bud it was noted that within ten minutes after the petals began to separate a visitor (Ceratina dupla) appeared and began delving into the base of the stamens. Here, as well as among some of the other flowers observed, it was noted that while a given insect is visiting certain flowers they usually confine themselves to that species alone, this of course being advantageous in effecting cross-pollination.

Visitors: *Coleoptera, Trichius piger, Strigoderma arboricola, Centrinus scutellum-album; Hymenoptera; Microbembex monodonta, Agapostemon radiatus, Bombus americana, Vespa borealis, Ceratina dupla.*

Cornaceae (Dogwood Family).

Cornus amomum. "Here the flowers are homogamous with exposed nectar, secreted by a ring surrounding the style. The stamens and stigmas develop simultaneously. The anthers are introrse and at the same level as the stigma, though some distance from it. Larger insects will effect cross-pollination while small flies and beetles, owing to their erratic movements, will sometimes effect cross-, sometimes self-pollination."[5]

Visitors: *Diptera; Lucilia caesar, Polenia rudis; Coleoptera; Cyrtophorus verrucosus, Cryptorhopalum triste; Hymenoptera; Elis plumpies, Polistes pallipes, Xylocopa virginica, Microbembex monodonta.*

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[4]See Op. cit., II. 458–459.
[5]Op. cit., II. 518–519.

Rubiaceae (Madder Family).

Cephalanthus occidentalis (Button Bush. This curious plant with flowers arranged in a sperical cluster offers nectar to several species, the only one taken being Eristalis tenax. The Humming Bird previously recorded was also a visitor.

Compositae (Composite Family).

Cirsium arvense (Canada Thistle). Numerous visitors were collected on this Composite, as follows:

Visitors: *Diptera; Odontomyia virgo, Lucilia sericata, Stratiomyia lativentris, Helophilus chrysostomus, Syrphus americanus, Muscina assimilis, Eristalis flavipes, Eristalis tenax, Stomoxys calcitrans; Lepidoptera; Chrysophanus thoe, Argynnis cybele.*

Apocynaceae Dogbane Family).

Apocynum hypericifolium. (Clasping-leaved Dogbane).

Visitors: *Diptera; Chrysopus moereus, Phormia regina, Eristalis dimidiatus, Stratiomyia lativentris; Lepidoptera; Argynnis cybele, Chrysophanus thoe, Harisina americana, Alypia octomaculata; Coleoptera; Donacia pusilla; Hymenoptera; Microbembex monodonta.*

Asclepiadaceae (Milkweed Family).

"In the sub-family Cynanchatae the five filaments are broadened, generally fused into a tube, and provided with external appendages, . . . pollen aggregated into pollinia, attached in pairs to the clip glands of the large capitate stigma. The clips grasp the legs of the insect-visitors when the nectar-secreting spots are on the same radii as the stamens (Asclepias), or the proboscis if these spots alternate with the stamens. . . . The clips are thus drawn out of their recesses by the legs or proboscis of visitors, and transferred to other flowers. (Pinch-trap Flowers). The extremely specialized flower mechanisms are adapted to insect visitors in a very perfect manner, so that a comparison may be made with orchids, though in this case there is nothing like the same variety."[6]

Asclepias. Pinchtrap Flowers.

Pollination is here effected by the legs of insects.

Asclepias syriaca. This plant bears flowers of a kind adapted to bees, the claws of which become entangled in the clips and carry off the pollinia to be introduced into the stigmatic chambers of other blossoms. An odor of honey is exhaled. The petaloid appendages of the anthers are in the form of fine fleshy nectar pockets, which alternate with the clips. From the bottom of each

[6]Op. cit., III. 90.

of the nectar pockets arises a curved horn-shaped process that bends inwards over the stigmatic disc.

"An insect searching for nectar slips about on the smooth flowers which make up the umbel until its feet get a firm hold in the lower part of a slit. When it wishes to go and draws up the leg the claws are guided upwards in the slit so that the clip becomes attached to the foot. During the subsequent movements the pollinia are introduced into one of the slits of another flower, and effect cross-pollination, while at the same time another clip affixes itself.

The development of the pollinia was investigated by Corry. He also found that flowers are infertile not only with their own pollen, but also with that from plants raised vegetatively from the same stock. Pollination is fully effective only when it takes place between flowers belonging to plants grown from the seeds of different stocks. Stadler worked out the histological details of the secretion of nectar and found that this is produced, not only in the petaloid cuculli, but also by internal nectaries on the inner wall of the stigmatic chamber. The approximated lower edges of the slits serve as nectar-covers for the latter.[7]

The fact of the plants being infertile to their own pollen as well as to pollen from plants raised vegetatively from the same stock probably explains the small number of fertile pods observed later in the season as compared with the large number of flowers originally observed.

Visitors: *Diptera; Pollenia rudis, Lucilla caesar, Chrysopus moereus; Lepidoptera; Harrisina americana; Hymenoptera; Microbembex monodonta.*

Asclepias incarnata (Swamp Milkweed).

Visitors: *Diptera; Peleteria robusta, Midas calvatus, Phormia regina, Lucilia sericata, Phthiria sulphurea; Lepidoptera; Anosia plexippus, Satyrodes eurydice, Argynnis cybele; Coleoptera; Donacia pusilla Hymenoptera; Microbembex monodonta.*

Asclepias tuberosa (Butterfly-weed).

Visitors: *Lepidoptera; Harrisina americana, Anosia plexippus; Hymenoptera; Microbembex monodonta, Xylocopa virginica.*

Bignoniaceae (Bignonia Family).

Tecoma radicans. In making collections on this plant it was found that most of the visitors had little to do with pollination but were busy collecting some material from the calyx. The nectar, which is secreted at the base of the long corolla-tube is available to certain insects only. The arrangement of the stamens

[7]Op. cit., III. 93–94.

and pistil is interesting as they were found in every case to be on the upper side of the fused corolla-tube so that an insect of similar proportions to a Bombus would be effectual in cross-pollination.

Visitors: *Diptera; Mesogramma geminata; Coleoptera; Strigoderma arboricola; Hymenoptera; Polistes pallipes, Microbembex monodonta, Chorion caeruleum, Spharophtalma ferruginata, Agapostemon radiatus.*

Family **Labiatae** (Mint Family).

Monarda fistulosa. (Wild Bergamot).

Visitors: *Lepidoptera; Hemaris diffinis; Hymenoptera; Bombus separatus, Agapostemon splendens, Apathus citrans, Cetrania dupla.*

Nepeta cataria. (Catnip).

Visitors: *Diptera; Eristalis tenax, Mesograpta marginata; Lepidoptera; Pieris rapae, Chrysophanus hypophlaeas; Coleoptera; Trichius piger; Hymenoptera; Ceratina dupla, Elis plumipes, Microbembex monodonta, Coelioxys 8-dentata, Megachile pruina, and Megachile sp.*

Pontederiaceae (Pickerelweed Family).

Pontederia cordata. Here we have an example of a tri-morphous flower. Apparently no observations had been made on this plant, as Knuth made no record of such. On this account special care was taken in collecting and labeling the various visitors. During the collecting it was noted that a bee-fly (Eristalis flavipes) visited about sixty individual flowers, on several spikes, during a one-minute period.

Visitors: *Diptera; Helophilus chrysostomus, Eristalis flavipes; Lepidoptera; Hemaris thisba, Papilio polyxenes, Pieris rapae; Coleoptera; Megilia maculata, Strigoderma arboricola, Disonycha pennsylvanica, Trirhabda tomentosa; Hymenoptera; Bombus virginicus, Agapostemon splendens, Agapostemon radiatus, Megachile* (several species unidentified)

In the above list of plants studied we have seen various types of pollination, in fact, hardly two of the families show any close similarity. Many more collections might have been made on the plants studied, as well as others of the same vicinity, but time would not permit. Insects laden with pollen and others who sought only nectar were observed but no special studies were made of these. It is the chief aim of this paper to emphasize the broadness of this field of work on Cedar Point and, possibly, to bring the subject to the attention of some one who can add or encourage succeeding chapters on this subject for the NATURALIST.

MEETINGS OF THE BIOLOGICAL CLUB.

Orton Hall, March 7, 1911.

The meeting was called to order by the President, Dr. Dachnowski, and the minutes of the preceding meeting read and approved. The President then introduced Dr. Wm. McPherson, of the Department of Chemistry who addressed the society on The Formation of Carbohydrates in Plants. The address was a review of the speaker's recent paper in Science on this subject. He gave a summary of the theoretical and experimental results accomplished up to the present time and emphasized the necessity of the botanist and chemist working conjointly in the solution of the intricate problems presented. The address was followed by a lively and interesting discussion.

The next topic of the evening was the second of a series of papers on the History of Biology. The period from Galen to Lamarck was treated in a very interesting manner by Miss Marie McLellan.

No business being presented the society adjourned.

Bertram W. Wells, *Secretary.*

Orton Hall, April 4, 1911.

The President, Dr. Dachnowski, called the meeting to order and the minutes of the preceding meeting were read and approved. Dr. R. J. Seymour then read a paper on A Theory of Nerve Activity, in which he presented an interesting theory proposed by Herring. This theory supposes the nerve fibres to be qualitatively and inherently different. The hypothesis was discussed in its various aspects and it was pointed out that while not yet proven the theory had no weighty arguments against it.

Mr. Clell L. Metcalf, followed with the third of a series of papers dealing with the history of biology, discussing the period from Cuvier to Pasteur. His paper was particularly valuable in that it made prominent a number of the less well known biologists of that period.

Mr. A. R. Shadle reported that he had observed a pair of evening grosbeaks on March 19th, at Delaware. Ohio. This, it appears, is one of a number of observations made this year of this western bird in the eastern Mississippi Valley and New England.

No business being presented the society adjourned.

Bertram W. Wells, *Secretary.*

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CLIMATIC CONDITIONS AND PLANT GROWTH IN SOUTHWESTERN OHIO IN 1908 AND 1909.

BRUCE FINK and VERNON LANTIS.

The spring of 1908 was cold, wet and backward, and it was almost impossible to plant early in fields or gardens. It rained or snowed nearly every day in April. The sky cleared before noon on the second day of May, and there was no further precipitation of moisture at Oxford, Ohio, where the observations given in this paper were made, until the twentieth of June, except two showers that barely laid the dust. July second, third and fourth gave showers, which altogether wet loose soil down one to two inches. Similar showers came on the fourth and fifth of August and again on the twelfth and seventeenth of the month, but at no time was loose soil wet down more than two inches. A rain on the twenty-eighth of September wet down one inch, and another like it came during the last week of October. From the middle to the last of November, we had several light showers that set the grass growing. The soil of cultivated fields was watched for three days after each shower or series of showers, and for six months, from the second of May to the middle of November, it was at no time wet by rain to a depth greater than two inches. The total number of light rains during the six months was nine. The drought that occurred during these six months was probably the most severe and disastrous known in this locality since its settlement.

The precipitation for March and April, 1908, was excessive, and the government Monthly Weather Review for both months put us in the area of four to six inches. We were also put in the area of four to six inches precipitation for May, 1908; but this is very likely an error of compilation from few stations for a large area, since so much precipitation probably did not occur before

*Contributions from the Botanical Laboratory of Miami University. VII.

noon of the second day of the month. For June we were put in the area of 2 to 4 inches, with a considerable area of 0 to 2 inches a short distance north of us, extending from Illinois to the Atlantic coast. This is an error, and we should have been included in the latter area. For July we were near the border of a small area marked 0.83 inches. We were in this area again in August and September; and the area gradually increased until it covered a large portion of the United States east of the Mississippi River, and there was inaugurated one of the most extensive and severe droughts ever experienced in the region. The area was still larger in October, extending from the Gulf of Mexico far north into Canada with precipitation ranging from 0 to 2 inches and marked about 0.25 inches for our area. The dry area changed form in November, the northern and southern portions of it receiving more precipitation, but we were still in the area with precipitation not exceeding one inch for the month. The map for December shows another change of form of this area, but our region is still included with 0 to 2 inches precipitation.

Putting together our local observations of showers, which were carefully recorded, and the government reports, it is certain that however the areas of drought changed from the first of May, 1908, until the first of January, 1909, our area where observations were made, at Oxford, was always included. In Chart XI of the Monthly Weather Review for May, 1909, our area is included in the only one in the Mississippi valley having a deficiency of precipitation as high as 10 inches for the year 1908. The area is a small one covering about one-fourth of southwestern Ohio and extending westward to Indianapolis. The Ohio portion of the area extends to the south boundary of the state at Cincinnati. This Review says that the Ohio valley experienced "one of the most disastrous droughts in the meterological history of the district. * * * The drying up of the streams and springs greatly inconvenienced farmers in procuring water for their cattle and domestic supplies, and the supplies to cities and towns were greatly reduced. * * * The occurrence of this drought rather late in the season of crop growth and development did not result in such widespread disaster to agricultural interests as might have resulted had it occurred slightly earlier." The above quotation expresses well the conditions in towns and in the country as seen in October and November, 1908, while botanizing in the Miami valley. However, the drought was on at Oxford, and at least in other portions of Butler County, by the last of May so that vegetation suffered more severely here than in most other portions of the country that suffered from drought in 1908. One of the writers visited northern Illinois the latter part of September, and central Kentucky a month later. All of the region covered was reported very dry, but the region of dead grass scarcely extended forty miles from Oxford, either southeast or northwest.

It is unfortunate that no record of precipitation of moisture is kept nearer Oxford than Cincinnati, 30 miles distant. However, the figures kept there are valuable for our purpose and are given below:

THE RECORD OF PRECIPIATTION AT CINCINNATI FOR 1908.

January	1.40 inches.	Relation to normal precipitation	—2.0	inches.
February	4.50	" " " " "	+1.2	"
March	3.66	" " " " "	0.0	"
April	4.07	" " " " "	+1.1	"
May	5.84	" " " " "	+2.3	"
June	2.00	" " " " "	—2.0	"
July	0.83	" " " " "	—2.7	"
August	1.69	" " " " "	—1.6	"
September	0.26	" " " " "	—2.0	"
October	0.35	" " " " "	—2.1	"
November	1.09	" " " " "	—2.1	"
December	1.60	" " " " "	—1.3	"
Total	27.29 inches.	Deficiency for the year,	11.13	inches.

Cincinnati does not fall within the area given by the government reports as having a deficiency as high as 10 inches for the year; but the precipitation for the year was only 27.29 inches, which is, according to the figures of the government observations, 11.13 inches below the normal 38.42 inches for the station at Cincinnati. The record of precipitation at Cincinnati for May very probably exceeds ours, and our deficiency for the year was almost certainly not less than 14 inches. Taking into account our lack of rain in May and the table for Cincinnati, which shows a deficiency of 13.80 inches for the last seven months of the year, it will be seen that our deficiency for the last eight months of the year was probably more than 16 inches.

We shall want to compare climatic and vegetation conditions for 1908 with those obtaining in 1909, and the precipitation record for Cincinnati for 1909 is given below to be used in these comparisons:

THE RECORD OF PRECIPITATION AT CINCINNATI FOR 1909.

January	2.50 inches.	Relation to normal precipitation	—0.8	inches.
February	5.65	" " " " "	+2.4	"
March	2.44	" " " " "	—1.2	"
April	3.62	" " " " "	+0.7	"
May	4.21	" " " " "	+0.7	"
June	6.05	" " " " "	+2.1	"
July	3.83	" " " " "	+0.3	"
August	1.82	" " " " "	—1.5	"
September	1.30	" " " " "	—0.9	"
October	3.20	" " " " "	+0.7	"
November	1.42	" " " " "	—1.8	"
December	2.40	" " " " "	—0.5	"
Total	38.44 inches.	Excess for the year	0.02	inches.

The figures for 1909 show the year to have been about normal for total precipitation, but to have had an excess of 4.4 inches for the four growing months, April, May, June and July. The

bearing of this excess on our studies of vegetation will be seen later. It is remarkable that, though the month of August showed numerous heavy storms in southern Ohio and the northern half of Kentucky, with rainfalls of more than 3 inches in twenty-four hours, and in two instances more than 4 inches, the station at Cincinnati showed a record below normal. In spite of this record, August, 1909, was a very wet month over the portions of Ohio and Kentucky named.

The year 1908 was regarded a very dry one for Ohio generally and the following year a wet one. In order that the conditions endured by vegetation in southwestern Ohio may be compared with the average conditions endured over the state, the precipitation records for the two years are given below:

PRECIPITATION RECORDS FOR OHIO IN 1908 and 1909.

	1908	1909
January	1.82 inches	3.24 inches
February	4.10 "	5.39 "
March	2.43 "	2.77 "
April	3.69 "	4.13 "
May	4.72 "	4.72 "
June	2.52 "	5.86 "
July	4.08 "	3.90 "
August	2.59 "	3.68 "
September	0.58 "	1.56 "
October	1.17 "	2.46 "
November	1.06 "	1.93 "
December	2.33 "	2.68 "
Totals	31.09 "	42.32 "

The mean annual precipitation for the state for twenty-seven years, according to the meteorological summaries published by the Experimental Station at Wooster is 37.56 inches. This makes 1909 little less above the average for total precipitation than was 1908 below, the deficiency for the latter year being 6.49 inches. This deficiency is to be compared with one of 10 to 12 inches or more endured by vegetation in southwestern Ohio in 1908.

The monthly mean temperatures for 1908 and 1909 are as follows in degrees Fahrenheit:

	1908	1909
January	29.1 degrees	32.2 degrees
February	26.6 "	34.7 "
March	45.5 "	37.3 "
April	51.7 "	49.1 "
May	62.2 "	58.7 "
June	69.2 "	70.1 "
July	73.9 "	66.4 "
August	71.2 "	72.1 "
September	68.0 "	63.7 "
October	54.1 "	49.2 "
November	41.7 "	40.4 "
December	33.4 "	26.1 "
Year	52.1 "	50.7 "

From the tabulation it is seen that the year 1908 was 1.4 degrees warmer than 1909; but what is more to the point, the warm growing months from April to September inclusive averaged 2.8 degrees warmer in 1908 than in 1909. This higher temperature made the drought more disastrous for plant life.

A porous cup atmometer was operated near Oxford, by Professor S. R. Williams, through the months from June to September, 1908, inclusive. The work was done for Messrs. Burton E. Livingston and Forrest Shreve, who have kindly given us the figures for use. Without correcting for depth, the figures are valuable in showing the atmospheric conditions under which vegetation existed here for these months, and in making possible comparisons with those obtaining in other portions of the country. The porous cup atmometer records the evaporating power of the air as this affects the water layer covering the moist clay surface of the cup. This surface is in many respects comparable to that offered by transpiring foliage under the influence of air conditions. The cups were operated during the same months at a large number of selected stations in various portions of North America, and the results obtained near Oxford may be compared readily with those found elsewhere. The average weekly evaporation in the vicinity of Oxford was as follows: June, 132 cc.; July, 182 cc.; August, 211 cc.; September, 212 cc. The evaporation for June over the region east of the 100th meridian was somewhat more than 100 cc. per week. In July there was a local area covering northeastern Ohio, eastern Michigan and a large part of Pennsylvania and New York that showed a weekly average of about 200 cc. The conditions remained about the same over this area during August. Comparison proves that we were, during all of this time, in a region of very dry atmospheric conditions where the evaporation was high, compared with records for other portions of eastern North America.

The evaporation from the porous cup atmometer is independent of soil moisture and depends upon the atmospheric conditions. Therefore, conditions of soil moisture can not be deduced from evaporation figures, but must be worked out separately. Our study of soil moisture conditions began early in October, 1908, when the drought was at its height and the cumulative effect on the soil was marked. The study was continued for nine months, extending into July, 1909. The results would have been more valuable, had the study begun five months earlier. Below is given the table of soil moisture:

TABLE OF SOIL CONDITIONS.

Soil	Can	Dates 1908–1909	Location	Depth in cm.	Weights in Grams			Water per cent moist	Water per cent dry
					First	Second	Can		
Red Clay	No. 1	Oct. 8	Campus two rods	36	853.00	787.61	125.05	8.98	9.87
"	No. 2	Oct. 8	west of Brice	36	833.76	769.85	125.10	9.02	9.91
"	No. 3	Oct. 8	Hall. Station	56	869.19	786.96	126.39	11.07	12.45
"	No. 4	Oct. 8	No. 1.	56	961.00	867.75	120.42	11.09	12.48
"	No. 5	Oct. 8		81	885.20	805.28	121.65	10.47	11.69
"	No. 6	Oct. 8		81	935.10	850.00	125.70	10.51	11.75
Red Clay	No. 1	Oct. 15		41	985.62	871.74	125.12	13.23	15.25
"	No. 2	Oct. 15	Campus south of	41	905.85	803.38	125.89	13.11	15.12
"	No. 3	Oct. 15	Main Building	56	955.93	833.69	126.45	14.71	17.28
"	No. 4	Oct. 15	by old flag pole.	56	1006.07	875.00	120.60	14.80	17.37
Red and White Clay	No. 5	Oct. 15	Station No. 2.	13	855.80	816.31	122.00	5.38	5.69
" " "	No. 6	Oct. 15		13	825.90	787.97	125.90	5.42	5.73
Loam and White Clay	No. 7	Oct. 21	Bruce Fink's	26	895.80	799.96	122.35	12.39	14.14
" " "	No. 8	Oct. 21	young orchard.	26	866.45	775.19	125.61	12.32	14.05
" " "	No. 9	Oct. 21	Station No. 3.	50	788.05	708.03	125.46	12.08	13.74
" " "	No. 10	Oct. 21		50	840.79	749.59	125.33	12.75	14.43
Loam	No. 1	Nov. 6	Bruce Fink's	36	832.52	704.57	121.70	18.08	22.06
"	No. 4	Nov. 6	garden.	36	833.87	720.78	120.30	15.84	18.84
"	No. 5	Nov. 6	Station No. 4.	53	941.34	795.50	121.98	17.80	21.65
"	No. 10	Nov. 6		53	772.32	657.00	125.83	17.84	21.71
Loam and White Clay	No. 2	Nov. 6	Bruce Fink's	38	982.11	864.80	125.00	13.69	15.86
" " "	No. 7	Nov. 6	young orchard.	38	865.65	763.46	122.50	13.75	15.94
" " "	No. 3	Nov. 6	Station No. 3.	53	1033.52	930.70	125.75	11.33	12.77
" " "	No. 6	Nov. 6		53	806.65	728.00	125.83	11.55	13.06
Loam	No. 1	Dec. 23	Bruce Fink's	27	876.50	785.23	124.86	12.14	13.82
"	No. 2	Dec. 23	garden.	27	903.40	816.42	124.88	11.17	12.58
"	No. 3	Dec. 23	Station No. 4.	48	769.13	689.86	126.00	12.32	14.06
"	No. 4	Dec. 23		48	866.24	755.20	120.05	14.88	17.48

Loam and White Clay	No. 5	Dec. 23	Lower Campus north of oak. Station No. 5.	29	1015.00	948.48	121.95	7.45	8.05
" " "	No. 6	Dec. 23		29	1012.00	912.00	125.76	7.90	8.58
" " "	No. 7	Dec. 23		40	991.14	912.26	122.92	9.09	9.99
" " "	No. 8	Dec. 23		40	1001.50	928.00	123.80	8.37	9.14
Loam and White Clay	No. 1	Feb. 12	Lower Campus. Station No. 5.	48	787.50	655.62	124.87	19.90	24.85
" " "	No. 2	Feb. 12		48	831.30	691.09	124.90	20.19	25.29
" " "	No. 3	Feb. 12		66	848.00	737.30	125.85	15.33	18.11
" " "	No. 4	Feb. 12		66	912.70	788.36	120.30	15.69	18.61
Loam and White Clay	No. 5	April 19	Lower Campus. Station No. 5.	53	857.03	700.92	121.82	21.23	26.96
" " "	No. 6	April 19		53	812.15	663.66	125.86	21.67	27.67
" " "	No. 7	April 19		35	837.25	684.31	122.20	21.39	27.21
" " "	No. 8	April 19		35	827.02	677.24	121.29	21.31	27.09
Loam	No. 1	July 8	Bruce Fink's garden. Station No. 4.	30	902.28	733.80	125.30	21.68	27.69
"	No. 2	July 8		30	857.50	699.80	125.57	21.55	27.46
Loam and Clay	No. 3	July 8		54	880.00	717.25	126.40	21.60	27.55
" "	No. 4	July 8		54	794.51	650.00	120.38	21.41	27.09
Loam and White Clay	No. 5	July 8	Bruce Fink's young orchard. Station No. 3.	28	972.20	798.37	122.24	20.45	25.71
" " "	No. 6	July 8		28	808.70	665.92	126.08	20.92	26.45
Yellow Clay and Sand	No. 7	July 8		62	873.12	762.50	125.20	14.79	17.36
" " "	No. 8	July 8		62	822.13	703.00	121.63	17.08	20.60

In the soil studies, two samples were taken from the same place and the same depth at the same time in order that each might serve as a check upon the other. In order to compare soil moisture for different locations, determinations were made of soil taken from both places on the same day and at about the same depth. In order to decrease the chances of error, a considerable amount of soil was taken in each sample. The drying process was continued until several weighings made at intervals of four or five hours, gave exactly the same results. In no case was the temperature allowed to rise to 100° C. The instruments used were a shovel, a hoe, a meter rule, a number of quart tin cans, and an oven. The geotome was not used because the amount of soil taken for each sample made this instrument impracticable.

The location of a station once decided upon, all the soil was quickly removed to the depth at which the two samples were to be taken. If any loose soil rolled into the excavation before the samples were secured, it was carefully removed, so that the samples would be entirely of the soil at the depth decided upon. The excavations were made large enough so that a surface of about two square feet would be exposed. Then a layer of soil not exceeding one inch in depth was loosened carefully so as not to get any soil from a higher level mixed with it, put into the cans, and the lids tightly sealed. The cans were taken to the laboratory, where they were weighed. The lids were then removed and the drying process begun. In some instances the drying extended over a period of four days, the cans being kept where they would be undisturbed and at a temperature below 100° C. so that no humus would be burned. After the drying was completed, the cans were weighed again and the percentage of moisture for both moist and dry soil calculated. For instance in the first sample in the table (853—787.61)÷(853—125.05) gives the proportion of moisture relative to the weight of the moist soil. This reduced to per cent gives 8.98. For getting the per cent dry soil weight for the first sample we used (853—787.61)÷787.61—125.05). The five stations were selected mainly to represent different types of soil, as the red clay of station number one, the mixture of red and white clay of station number 2, the loam and white clay of station number 3 and the loam of station number 4. Stations numbers 1 and 2 were in the open and heavily sodded. A large elm stood 16 feet from the first station. There were no trees within 100 feet of the second station. Station 3 was among apple trees planted in April of the same year. A poor crop of oats had been harvested; and the ground had been seeded to clover and timothy, which failed because of drought. The ground was hard and dry at the surface, and had not been stirred since sowing the grain in April. Station 4 was a rich, black loam that had been carefully worked all summer, up to the time when

the first samples were taken. Station 5 was of the beech forest type. The surface is nearly level at all of the stations. Stations 1 and 2 are 35 rods apart, and stations 3 and 4 are 15 rods apart. Stations 3 and 4 are 656 feet lower than stations 1 and 2, and about one-third of a mile distant. Station 5 is a few rods distant from station 2.

The difficulties of studies of soil moisture are very great owing to daily variations of temperature, of evaporation rate at different hours, and other variable factors. While we have given the per cents of water based both on moist soil and dry soil, we shall use in the discussion only the former. A given per cent of water in one soil may mean a very different condition for the plant than the same per cent in another soil, and a given per cent in any soil affects different plants differently. Clay soils will hold approximately 40 to 50 per cent of water; and most land plants can not secure water from clay when the per cent falls below 9 or 10, while few if any can secure water from such soil containing less than 6 per cent. Loams and humus will hold approximately 50 to 65 percent of water; and most plants cannot extract water when the percent falls below 10, and few if any when it falls below 6. Sand will scarcely hold more than 15 per cent of water, but most plants can still obtain water from sand when the per cent falls below one. Plants that can obtain sufficient water only when the per cent is high are hydrophytes, those that can obtain it when the per cent is moderate are mesophytes and those that can still obtain it when the per cent is low are xerophytes.

It will be seen from the table above that the soil moisture on October 8, 1908, at station number 1 had reached the point where mesophytes, which include most of the land plants of the region, whether wild or cultivated, would have great difficulty in securing water from the clay at a depth of 36 cm. At station number 2 on October 15, 1908, mesophytes could secure water from the clay at depths of 56 and 41 cm., but not at a depth of 13 cm., where even xerophytes might fail utterly to secure soil moisture. At station number 3, on October 21, 1908, mesophytes could secure soil moisture at 50 and 26 cm. deep, but with some difficulty. But at the same station, on July 8, 1909, mesophytes would have no difficulty in securing abundant soil moisture at these depths. At station number 4, on November 6, 1908, garden plants should be able to obtain soil moisture, though probably with some difficulty. But in this station, on July 8, 1909, garden plants would have no difficulty in securing sufficient soil moisture. At station number 5, in the heavy beech woods, most plants would not be able to secure soil moisture from the clay soil at depths of 29 and 40 cm. on December 23, 1908, while moisture could be secured easily at such depths on April 19, 1909. Hundreds of stations and daily testings throughout the season would be neces-

sary to give results as accurate as possible, but our figures indicate that most plants would fail to secure soil moisture or would secure it with difficulty at the depths tested on the dates on which the samples were taken in 1908. Our data are valuable only when correlated with the observations below regarding the character of plants that were able to remain green above ground throughout the season of 1908.

Related to the lack of rain after May 2, 1908, stands the fact that corn planted after the middle of May came up very unevenly and in some fields scarcely at all. Much of the corn failed to produce ears and dried up in August. Other fields, often near the poor ones, made a good showing of ears. The difference was due in part to difference in tending as well as to local climatic and soil conditions. The crop reports probably overestimate the amounts harvested in Butler County in 1908; but the bushels per acre reported for some of our principal crops for 1908 and 1909 respectively, are winter wheat, 16.2 and 16, oats 10.4 and 33, corn 28.1 and 34, potatoes 44.6 and 73. Winter wheat was a very unpromising crop in the fall of 1908, and much that was sown did not germinate until the following February. In some fields the seed failed completely in the fall. But a heavy snow came in January, 1909, and when this disappeared early in February, the seed had germinated; and in many places the fields were green with wheat about an inch high. Frost killed much of this, and the prospects were very poor. But the spring rains came, and the wheat stooled so that 25 and 30 stalks from one kernel were reported by reliable agriculturists. Thus, fields that were so thin in early spring that it seemed scarcely worth while to let them stand produced about a normal amount of straw, but too many stalks from a single kernel for a good yield. So the effect of the drought of 1908 was felt in the wheat crop of 1909 as well as in that of 1908. Of the other three crops, the average for 1908 was little more than half that for 1909, according to the statistics for the two years.

The pastures were brown and the grass dead above ground from the middle of June until late in November. The timothy and blue grass of the hay fields were dead above ground soon after the hay was cut. From the middle of August until November, the country, except cultivated fields, presented the appearance of a desert with scattered vegetation consisting of xerophytes with succulent stems, deeply penetrating roots, tough exteriors, or milky juice. In open fields, along roadsides and in yards and gardens were seen conspicuously resisting the drought, dandelion (Taraxicum officinale), mullein (Verbascum thapsus), moth mullein (Verbascum blattaria), wild carrot (Daucus carota), milk purslanes (Euphorbia maculata and E. preslii), amaranths (Amaranthus retroflexus, A. blitoides and A. graecizans), asters

(species of Aster), sunflowers (species of Helianthus), goldenrods (Solidago canadensis and S. nemoralis), plantains (Plantago major, P. rugelii and P. lanceolata), yard grass (Polygonum aviculare), docks (species of Rumex), goosefoots (Chenopodium album and C. urbicum), milkweeds (Asclepias cornuti), lettuces (Lactuca scariola and L. canadensis), purslane (Portulaca oleracea), evening primrose (Oenothera biennis) and crab grass (Panicum sanguinale). Some of the above ripened or succumbed sooner than others. In woods, in low meadows and along streams grasses and sedges were able to persist in good quantity, but on higher open ground wild grasses and sedges were for most part dead and brown above ground by the middle of August.

The leaves of many trees, especially maples and ashes, became dry and brown before the middle of September, and it was suspected that a considerable number of these would die the following season. The many planted trees of the campuses of Miami University and The Western College for Women, at Oxford, were carefully watched through the season of 1909. The campus of the former institution has a shallow soil, the solid limestone rocks being within three to six feet of the surface, while rocks have not been reached on the campus of the latter institution in digging, except in very low places. Many large, planted trees have died on the campus of Miami University since the summer of 1908; but only two planted trees have died on the campus of The Western during the same years, and these two were badly injured by *Cenangium abietis*. Of 213 maple trees on the campus of Miami University before the drought, 9 were dead in the fall of 1909; and 38 more were in a dying condition as shown by thin foliage or more frequently by more or less of the crown of the tree being dead. Of 90 planted ashes, 9 showed a larger or smaller number of dead branches, and 7 died before the summer of 1911. Of 10 spruces, 4 were in a dying condition in 1909. About 35 other trees died or were in a dying condition in 1909; but these were scattered through many genera, and while the number is large, great damage was not shown by any of the genera involved. Trees have been dying on the campus of Miami University in considerable numbers since 1908, and the dying is largely confined to the trees that showed the injurious effects of the drought of 1908. The superintendent of grounds for Miami University informs us that not a single large, planted tree on the campus died from 1898 to 1908, but that dying has been going on constantly since the latter date.

The contrast in crop conditions between 1908 and 1909 has been given above. Other contrasts in vegetation conditions were also very marked. In 1909, all kinds of herbaceous vegetation of the region was green and luxuriant throughout its natural cycle, and trees not considerably injured by the drought of the

previous year showed abundant foliage. *Botrydium wallrothii* and *Cyathus vernicosus* appeared on black loam of gardens and fields in such abundance as is seldom seen. In 1908 *Botrydium* and *Anthoceros* could not be found in sufficient quantity for class use; but in 1909, the latter, like the former, was remarkably abundant. It could be found in the average woods of the region, wherever soil was bare, in five minutes. This is remarkable since in ordinary years, *Anthoceros* is rarely seen here and only along shaded clay banks. The fleshy fungi were also very abundant in 1909. At "Beechwood Camp," in August, students brought in such an array of *Russulae*, *Lactariae*, *Amanitae*, *Boleti*, and other forms as is seldom seen in these days of depleted forest lands. Contrasted with this, there was almost a total absence of these fungi during the same month in 1908. Of the *Boletaceae*, only a few specimens of *Suillellus luridus* were seen in 1908, while *Gyroporus castaneus*, *Tylopilus felleus*, T. *indecisus*, *Ceriomyces auriporus*, C. *retipes*, C. *miniato-olivaceus*, C. *bicolor*, C. *fumosipes*, C. *communis*, *Suillellus luridus*, *Strobilomyces strobilaceus* and *Boletinellus merulioides* were all collected in 1909.

To have accomplished results of great ecologic value, it would have been necessary to keep several operators at work during two years, obtaining data regarding precipitation, temperature, light, evaporation, soil, and vegetation conditions in a limited area and at the level of vegetation. Though it was not possible to carry out the work with such detail and accuracy, it is believed that our results are valuable for record for the locality and the state.

LIFE-HISTORIES OF SYRPHIDAE II.

C. L. Metcalf.

Paragus bicolor (Fabricius).

Larva.

Length about 8 mm., height about 2.5 mm., width 3.25 mm. (Fig. 21). In superficial appearance somewhat suggesting larva of *Didea fasciata fuscipes*.*

Elongate-oval in outline, somewhat flattened-dorso-ventrally, attenuated gradually to the obtusely pointed anterior end slightly to the truncate posterior end. The color of the integument is light yellowish brown, but it is semi-transparent and various tints of visceral organs show through, making a light line along each lateral carina limited medially by darker. The mid-dorsal region surrounding the black pulsating blood-vessel is a light brick-red color about one-third the width of the larva, due to underlying fatty bodies. On each side of this for a third the remaining width jet-black visceral matter shows through frequently in pulsating pockets. This is limited laterally by a little wider band of yellowish white as contrasted with the narrow remaining margin and the conical elevations which appear drab. However, the color varies considerably with different larvae and at different times in the same larva.

The integument is tough but pliable thrown into numerous transverse folds; papillose but bare.

There are apparently twelve body-segments the anterior three strongly retractile so that when the larva is at rest segment four usually forms the anterior outline of the body. Each of these segments except the first few and the last is marked by about four lateral wrinkles or folds and bears, as in *Didea*, twelve conical elevations each with a spine or bristle at the summit. (Fig. 22). For convenience of reference we may name these segmental spines and the elevations on which they are borne according to their position. Beginning at the mid-dorsal line on either side they are in order: median, dorsal, dorso-lateral, lateral and two ventro-laterals, a posterior ventro-lateral and an anterior ventro-lateral, as one is in front of the other. This will be made clear by refrering to Figures 27 and 28 where these spines are indicated on the puparium. The fourth and fifth body-segments in *Paragus bicolor* have the median, dorsal, dorso-lateral and lateral elevations of about equal size (see Fig. 21). The third and the sixth to the eleventh segments, inclusive, have the dorsal ones very much shorter, about one-sixth as large, almost obscure, and situated on the succeeding fold of the integument. The dorso-

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lateral elevations are continuous at their base with two of the transverse folds in each segment and these are so produced as to make a distinct, zig-zag, longitudinal carina along each side of the body. The lateral elevations make a similar underlying carina less pronounced. The ventro-laterals are small, situated on projecting folds antero-ventral to the laterals. Ventrally in segments five to eleven, there are seven pairs of small rounded bare elevations of the integument which serve as pro-legs.

The other appendages consist of mouth-parts, antennae and anterior and posterior spiracles. The mouth-parts are terminal; they consist (Fig. 32) of two beak-like jaws (Fig. 23, *d* and *f*), working vertically, and four pairs of mouth-hooks (Fig. 23, *a* and *e*). The upper jaw is a V-shaped chitinous piece with slender arms, sharply pointed at the apex; the lower one slenderer, more hooked, of solid chitin nearly to the base where there is a spur-like projection ventrally on either side. Three pairs of the mouth-hooks are at the sides of the jaws; slender, the bases embedded in the flesh for half their length, the outer one broader distally and with a lateral spur ventrally; the fourth pair consists of two triangular hooks well separated from the other parts along the side of the first segment. The mouth parts are all black, firmly chitinized and the jaws are continuous internally with broad chitinous plates surrounding the oesophagus (Fig. 23, *b*). Just dorsal to the mouth-parts is the pair of short antennae each with a basal sub-conical fleshy piece and two rounded terminal segments. (Figs. 21, *a*, and 23, *c*). On the anterior part of the third body-segment is a pair of very small spiracles (Fig. 21, *b*). These are difficult to see clearly but apparently consist of a crescent-shaped slit guarded by seven rounded teeth-like lobes (Fig. 24). The posterior respiratory organ (Fig. 21, *c*) consists as in other species of two short cylindrical appendages fused along the middle line and each bearing on the end three slit-like spiracles radiating from a dorsal circular plate. The appendage in *Paragus bicolor* (Figs. 25, 26), is slightly longer than broad, the length being from 0.25 mm. to 0.4 mm., the width 0.25 to 0.3 mm. About mid-length is a slight constriction beyond which the appendage is strongly chitinized and the surface smooth, testaceous brown; proximal to the constriction the surface of the tube is roughly papillose and nearly black. The spiracles are well elevated above the surface of the appendage and are noticeably curved in their extent. (Figs. 25 and 26, *b*).

The inter-spiracular spines* are inconspicuous but the one median to the rather inconspicuous circular plate (Fig. 26, *c*), is large, spoon-shaped, broad dorso-ventrally, narrower from side to side and concave laterally (Figs. 25 and 26, *a*).

* Inter-spiracular spine, a projection of the chitinous surface between any two of the spiracles on the posterior respiratory organ.

The anus is ventral on the last segment.

These larvae were first taken at Columbus, Ohio, on May 31, 1911, when a dozen or more of various sizes were collected on Curled Dock (*Rumex crispus* L.) very badly infested with an aphid (*Myzus* sp.).

On June 4, eggs and larvae were taken from the same host, the eggs hatching the following day. The young thus made their first appearance at this station the latter half of May and the first of June. At Lakeville, Ohio, seventy miles north-east, larvae of differing sizes were collected from both Curled Dock and Broad Leaf Dock (*Rumex obtusifolius* L.) June 15–18. At Sandusky, on Lake Erie, larvae of this species nearly full grown were collected from Curled Dock on June 21 and July 1. At Castalia, June 29, larvae were abundant on Common Burdock (*Arctium minus* Schk.) On July 8 both pupae and larvae were taken in considerable numbers from Burdock at Kelley's Island. Again on August 27th larvae were found on thistle (*Carduus* sp.) at Lakeville, Ohio, among aphids (*Aphis* sp.).

From all the observations made on this species two distinct generations seem evident: one appearing in spring at dates varying from the middle of May to the middle of June or a little later in different parts of the State, a second appearing in August and perhaps later.

On Rumex these larvae are to be found among the aphids (*Myzus* sp.) which cluster especially on the heads or flower spikes and the smaller leaves; on thistle on the upper tender parts of stems; on Arctium they are more especially on the under side of the large lower spreading leaves. They are parasitic on the aphid colonies catching the individuals with their mouth-parts and killing them by slowly picking out and sucking out all the soft body-contents within the chitinous wall. During this process the mouth parts are manipulated by strong muscles which also move the large chitinous plates about the oesophagus out and in like a battering ram. The anterior two or three segments are pushed inside the sac-like body-wall, and the contents very carefully and completely picked out all around and into the bases of the appendages. Empty skins are dropped and may sometimes be noted.

The larvae are sluggish when plenty of food is at hand, usually nicely protected by position among the aphids and somewhat by colors similar to those of the host plant. They can, however, move actively by looping movements with the assistance of the pro-legs. When in search of food the larva advances a short distance, raises the anterior half of the body and lashes it rapidly from side to side, then advances again and repeats the side lashing until it touches the desired food.

The only particular enemy noted is a small Ichneumonid parasite (*Bassus* sp.) which oviposits through the skin of the larva. The parasitic larva does not prevent the formation of a more or less complete puparium, but emerges as adult about four weeks after pupation of host by gnawing a small irregular hole in the anterior end of the puparium (see Fig. 36). The first indication of the presence of the parasite is usually a failure of the pupal envelope to inflate completely, remaining less rounded up dorsally and often with the anterior segments but little retracted ventrally. Very soon the pupa becomes darker in color than normal, in this species becoming purplish instead of testaceous brown. These characters should be easily told and one with a very little experience might do great good by destroying all such parasitized pupae before the hymenopteron has time to emerge.

Pupa.

Dimensions, average of ten: Length 5.3 mm., height 2.2 mm., width 2.4 mm. Pupation takes place within the indurated larval skin which becomes inflated dorsally and anteriorly, retracted ventrally so that the mouth comes to lie well back on the ventral side. As seen from above (Fig. 27) the puparium is near oval in outline but with sides somewhat straightened and with the breathing appendages giving a more extended outline posteriorly. From in front the puparium is almost circular in outline. As seen from the side (Fig. 28), the ventrum is nearly straight, dipping down slightly anteriorly and posteriorly, thence rounding up strongly to the dorsum. In many specimens the anterior end of the larva has been more strongly retracted ventrally and the anterior and posterior ends more equally rounded up than is shown in Fig. 28.

The color varies from brown-pink to darker sometimes with obliquely transverse banding of testaceous brown and blackish.

The long segmental spines contrasted with the short-dorsals, or their apparent absence on the principal segments, and the short posterior respiratory appendage with its prominent spoon-shaped spurs at the end, dorsally, should serve easily to identify the species.

Date of pupation: Columbus, June 6th and later; Lakeville, June 23 to 26; Sandusky, July 3 and later; Kelley's Island, Lake Erie, July 8 to 13. The duration in the pupa stage was from 5 to 15 days with the majority about 12 days.

The pupae are to be found lodged and fastened among the flowers in the spike and the axils of the leaves, or on the upper side of the leaves of the host plant. They are stuck to the leaves by their posterior end. Protective coloration may be of some importance to the pupae as well as to the larvae.

The adult emerges by pushing off a circular operculum from the anterior end of the pupa-case.

Adult.

Genus Paragus Latreille.

Description slightly modified from Williston, Bull. U. S. Nat. Mus., No. 31, 89, (1886), p. 17. Small nearly bare species, abdomen curved downward at the tip black or greenish black with yellow on the face and reddish on the abdomen. Head broader than thorax; antennae about as long as the head, first and second joints short third longer than first two together; arista before the middle bare. Face convex with an obtuse tubercle. Eyes pilose, narrowly contiguous and often with an area of enlarged facets on the upper anterior part in the male. Abdomen as wide as thorax and twice as long of nearly equal width throughout, a shallow transverse depression on each segment, the distal end bent downward. Hind metatarsi much thickened as long as the remaining joints together. Marginal cell of wing open, third longitudinal vein straight, anterior cross-vein near the base of discal cell, the last section of fourth vein sinuate, terminating in a right angle on the third vein at a considerable distance before the tip.

Paragus bicolor (Fabricius).

♂ ♀ Length 5–6 mm. Eyes pubescent, *the pile mostly grouped in two vertical stripes separated by a distinct vertical glabrous stripe* (Figs. 29, 30). Face in the female white pilose with a shining black stripe reaching from antennae to the oral margin, narrower below; *in the male wholly pure light sulphury yellow* with yellow pile. Oval margin and cheeks shining black. Antennae black with some whitish pollen, the under side of the third joint reddish. *Front of female narrowed above*, not more than half as wide at the vertex as at the base of the antennae (Fig. 30); shining black narrowly dusted with whitish on the sides below, the latter not quite reaching the light color on the sides of the face; frontal triangle sulphur yellow, the eyes touching midway, and for about one-fifth the distance, between the anterior ocellus and the base of the antennae; "vertical triangle black light pollinose in front. Thorax black, a little shining with yellowish pile, *in front with two whitish pollinose stripes.* Pleurae silvery white pilose. Scutellum with a whitish border not extending to the anterior angles. Abdomen chiefly red, but variable in color; first segment black; second segment, often wholly black sometimes more or less red behind, sometimes only black on the sides. The black usually extends narrowly along the sides of the third segment, sometimes of the fourth and fifth also; rarely, the third segment has a blackish band. Pile on the sides of the segments in front and on the lateral margins, and on the fifth segment, white, elsewhere obscure. Legs variable, frequently the basal portion of the front and middle femora and the hind femora except the tip are black, elsewhere yellowish. Wings, nearly hyaline; stigma, dilutely yellowish."

Paragus tibialis (Fallen).

Larva.

Length about 7.5 mm., width 2 to 2.5 mm., height 1.5 mm. Similar in superficial appearance to the previously described *Paragus bicolor* but slenderer and smaller. Color markings variable. Ususally the heart line is rather prominent as is also a similar looking dark line along each side of the body about under the dorsal segmental spines. The reddish color is of much less extent than in *P. bicolor* and is largely replaced by a sulphur yellow tinge. In some specimens the general color is uniform light yellowish brown. The segmental spines are shorter and situated on smaller conical elevations than those of *P. bicolor* (Fig. 32), but the dorsal one in segments 6 to 11 is less reduced proportionately, being about one-third as long as the median and dorso-lateral ones. (See Fig. 31).

The most convenient means of separation of the two species in the larval stage is in the length of the posterior breathing appendage. This in *P. tibialis* ranges from about 0.4 mm. to 0.65 or 0.7 mm., with an average of about 0.5 mm. as compared with *P. bicolor* where the length is near 0.3 mm. The width at the tip is about 0.25 to 0.3 mm. as in *P. bicolor*. The appendage besides being distinctly longer is somewhat more bifurcate at the tip in *P. tibialis* and the general surface is slightly more depressed between the spiracular elevations. This will be made clearer by reference to Figs. 25, 26, 33 and 34.

Larvae were taken from common Burdock (Arctium minus Schk.) at Lakeville, Ohio, June 21st; at Sandusky, Ohio, from July 30 to August 5; and at Kelley's Island, July 8th. They were found on the upper, but chiefly on the lower side of the leaves of Burdock parasitic in colonies of aphids (species undetermined) the body fluids and viscera of which they devour in the usual manner.

They were found parasitized to a slight extent by the hymenopteron *Bassus sp.*

Pupa.

Dimensions, average of five: length 4.3 mm., width 1.8 mm., height 1.75 mm. Nicely rounded out anteriorly and dorsally, flattened to the surface of the leaf ventrally and attenuated strongly to the posterior respiratory appendage both by depression and by compression (Fig. 35). The posterior appendage is very frequently turned to one side or other from the middle line. General color uniform pale brown to darker, the six spiracular elevations black.

Compared with *P. bicolor* the puparium is less rounded up posteriorly, more attenuated (Fig. 35, cf. Fig. 28). The characters of the posterior, breathing appendage and the segmental spines

remain essentially as in the larva viz., the appendage is longer than in *P. bicolor* the tubes slightly divergent at the tip and the spoon-shaped spine at their tips longer; the segmental spines as a whole are shorter, the dorsal ones in segments 6–11 becoming inconspicuous or entirely invisible.

Pupa from the larva taken at Lakeville, Ohio, June 18th, was formed June 23. Pupae were common in the field at Kelley's Island, July 8. They were taken at Sandusky, Ohio, August 2. Duration in the pupal stage was from 5 to 11 days. Pupation is accomplished within the hardened larval skin. The posterior part especially flattens out on the surface of the leaf becoming glued fast to it while the anterior end becomes inflated, the head segments being retracted ventrally.

For the emergence of the pupa the operculum splits off usually between larval segments 5 and 6 dorsally and just back of the mouth-parts ventrally. The adult emerges with wings crumpled and a conspicuous U-shaped loop in the costal margin about the termination of the first longitudinal vein. The wings expand and harden in an hour or so and the fly is ready for flight.

Adults have been taken from the tenth of May to the latter part of August more often in the first half of June and the first half of August. They are flower feeders but found most commonly in deep meadowy wooded spots hovering in the sunlight or may be taken by beating.

Adult.

Paragus tibialis (Fallen).

♂ ♀ Length 3 to 5 mm. Antennae nearly as long as the head, blackish brown varying to yellowish brown on parts. Face light yellow pilose; yellow on the sides with a broad median black band from antennae to oral margin; projecting below and with a distinct tubercle above the oral margin (Fig. 37). Front in female black, with black pile of nearly equal width throughout (Fig. 38). Frontal triangle in male yellow, vertical triangle large, black, yellowish pilose at the apex, elsewhere the pile darker. Eyes pilose, *the pile not massed in two vertical stripes,* dilute. Thorax entirely greenish-black, shining, with yellowish pile. *No yellow on the scutellum.* Legs light yellow, black on the base of the femora; the hind femora all black except at the tip. Wings hyaline slightly tinged with grayish.

Schiner in Fauna Austrica cites several varieties separated on the color of the abdomen. The ones I have reared from larvae show the following abdominal markings: In the male the first and second segments are black, the following ones reddish brown with some black, whitish yellow pilose. In the female entirely greenish-black like the thorax with more or less whitish pile.

EXPLANATION OF PLATE XIX.

Figures 21–30 *Paragus bicolor* (Fab.)

Fig. 21. Mature larva x 10; *a*, antenna; *b*, anterior spiracle; *c*, posterior respiratory organ.

Fig. 22. A segmental spine of the larva x 40.

Fig. 23. Antero-lateral view of mouth-parts of larva, much enlarged; *a*, outer pair of mouth hooks; *b*, broad chitinous plates surrounding the oesophagus; *c*, antenna; *d*, upper jaw; *e*, three pairs of lateral mouth-hooks; *f*, lower jaw.

Fig. 24. Right anterior spiracle highly magnified.

Fig. 25. Dorsal view of posterior respiratory organ x 60; *a*, the dorsal spine; *b*, one of the radiating spiracles.

Fig. 26. End view of posterior respiratory organ x 70; *a*, its dorsal spine; *b*, a spiracle; *c*, the circular plate.

Fig. 27. Dorsal view of puparium x 5; *a*, posterior respiratory organ; *b*, median segmental spine of sixth larval segment; *c*, dorsal and *d*, dorso-lateral spines of sixth and seventh larval segments, respectively.

Fig. 28. Lateral view of puparium x 5; *a*, posterior respiratory organ; *b*, median spine; *d*, dorso-lateral spine; *e*, lateral spine; *f*, posterior ventro-lateral; and *g*, anterior ventro-lateral.

Fig. 29. Adult male about seven times natural size.

Fig. 30. Front view of head of female x 12.

Figures 31–38 *Paragus tibialis* Fallen.

Fig. 31. Posterior part of a young larva from the side greatly enlarged.

Fig. 32. Segmental spine of a full grown larva x 40.

Fig. 33. Dorsal view of posterior respiratory organ of larva x 60; *a*, the dorsal spine; *b*, one of the paired radiating spiracles.

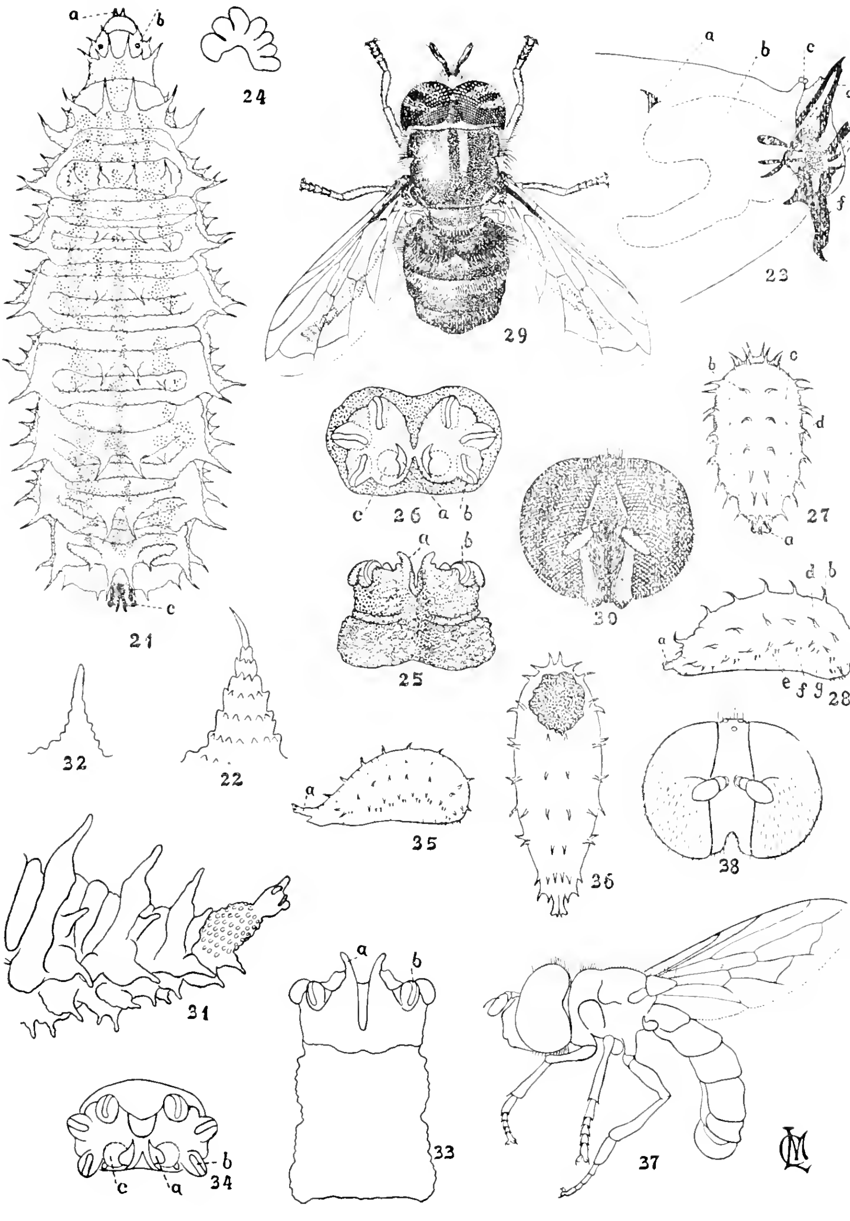
Fig. 34. End view of posterior respiratory organ x 60; *a*, its dorsal spine, *b*, a spiracle; *c*, the circular plate.

Fig. 35. Lateral view of puparium x 5; *a*, posterior respiratory organ.

Fig. 36. Puparium which has been parasitized by hymenopteron, *Bassus* sp. showing typical form and the irregular hole through which the parasite has escaped.

Fig. 37. Outline drawing of adult male from the side x 8.

Fig. 38. Head of female x 12.



METCALF on "Life-Histories of Syrphidae II."

FLUCTUATING CHARACTERISTICS OF APPLES.

C. H. Goetz.

In taking up the study of fluctuating characteristics in apples, the intention was to show in how far there was a fluctuation of characteristics in apples. The work was carried on at Pullman, Washington, during the years 1909 and 1910.

In the fall of the year as the apples ripened in the orchard of the Washington State College, there was gathered from the trees of fifty different varieties of apples, enough fruit to make one hundred apples of each variety, for use in the investigation. These apples were taken promiscuously from the trees. They were stored in boxes in the cold storage, each box being marked with name and number.

During the winter the apples were cut up for investigation and study. One-half of them were cut lengthwise for a study of the longitudinal outline form; for size; shape, form and size of tube, for shape of core line; depth, size and form of cavity and basin; for position of stamens, and length of stem.

The other half of the apples were cut into cross sections for the study of the core line or fibro vascular bundles; for size, shape and nature of cavities; for cross-section outline; for position form and nature of core.

These halves of the apples were as near as possible true halves. They were inked with indelible pencil on the face in such a way as to have them make clear cut and true impressions of the form and various characteristics of the apples as they were pressed upon paper.

Two impressions were made. The first impression was made on an absorbing paper, making a very strong impression. This was used for making a tracing of the apples. The second impression was made on a fine grained paper, to be used for further study.

The investigation of the fluctuating characteristics of the apples brings out the following:

1. That there is a more or less fluctuation in certain characteristics and that this is true more of certain varieties of apples than of others.

2. That certain varieties of apples show a tendency toward a constancy of characteristics, while others have a great tendency toward fluctuation.

Perhaps the most fluctuating characteristic in all apples is found in size, shape and appearance of the seed cavities.

Second to this comes the fluctuation in the length of the peduncle in any variety.

	Cavities	Size	Form	Lower Basin	Apical Basin	Peduncle	Tube	Core Line	Stamens	Core	Calyx
	%	%	%	%	%	%	%	%	%	%	%
Janet.	75	29	56	37	30	49	76	54	25	20	28
North Carolina.	80	30	45	44	35	66	82	33	24	61	23
Pickapoo.........	65	29	45	44	35	67	82	77	49	73	24
Smith.........	50	33	52	66	88	25	64	32	23	37	25
Limber Twig......	57	31	23	12	43	23	76	45	21	21	33
Houghtaling......	66	11	77	22	13	10	9	8	32	8	19
Ortley............	76	18	41	17	16	28	71	78	31	11	27
Rock...........	85	89	21	6	41	8	95	39	13	7	9
Jones...........	76	16	87	31	32	69	86	84	25	27	36
Gold Ridge	68	87	74	68	76	21	22	74	84	73	19
Agrippa...........	90	75	77	68	81	72	76	92	43	41	28
Nancy Jackson.	83	92	84	14	43	24	75	83	19	74	65
Shakleford..	69	37	68	67	39	49	63	84	42	77	9
Black Warrior......	71	6	9	88	25	86	78	68	14	75	8
Nelson.	8	33	85	4	13	93	92	86	10	7	5
Hugenot.	57	92	6	95	4	7	8	66	37	53	11
Goin....	88	89	58	59	77	84	17	58	76	78	20
Gill.....	73	76	69	32	21	65	18	86	17	58	21
Duncan	94	17	36	75	85	78	84	75	16	18	22
Stark..	77	46	65	66	42	41	61	47	16	89	26
Williams Early Red.	63	85	66	39	28	27	84	7	39	87	32
Stone's Eureka ...	59	13	82	21	32	15	8	18	29	67	26
Nansemond...........	65	50	48	53	34	43	38	54	65	35	46
Black Annette.........	14	48	38	53	16	33	38	54	65	46	44
Fink..................	63	92	37	84	32	24	79	15	96	42	10
Stayman.............	57	34	24	15	25	26	77	11	39	27	26
Kinnaird.............	72	54	37	25	43	32	76	85	88	87	13
Red Siberian.........	45	67	77	43	29	11	27	29	36	27	64
Andrews' Winter.....	67	77	66	25	28	74	72	61	28	67	26
Crotts................	51	96	36	28	19	23	17	18	8	16	9
Red Romanite.........	54	85	75	23	12	98	86	85	24	35	38
Yates................	68	62	74	34	28	69	80	70	42	60	31
Belmont..............	89	83	90	39	30	81	72	82	47	48	60
Vanoz................	78	88	16	37	19	10	11	32	24	60	28
Marshal...............	85	11	78	88	33	30	20	65	28	86	19
Arabka...............	70	69	84	35	27	56	65	37	74	46	35
Plumb Cider..........	53	53	76	35	52	81	20	95	49	63	83
Latah................	67	75	18	29	77	32	67	26	34	55	10
Hiley Eureka..........	66	54	63	27	37	38	64	84	82	53	73
Bomshell..............	76	53	77	73	83	56	25	73	54	68	26
Rome Beauty.........	73	83	29	18	20	92	14	13	21	88	15
Indiana Favorite......	63	53	27	38	44	28	83	48	47	88	23
Lowver...............	72	91	85	31	17	78	80	64	62	53	54
Fallen Water..........	59	90	51	80	69	70	53	72	78	88	55
Lankford..............	86	60	71	65	39	82	30	74	18	61	38
Lake Winter..........	58	60	16	10	82	26	77	11	72	31	33
York Imperial.........	57	94	95	97	38	29	8	14	83	12	10
Loy..................	84	64	75	88	64	29	84	56	43	58	40
Superior..............	62	90	16	87	83	36	88	89	19	85	9
Longevity............	71	86	74	28	42	28	78	17	29	65	23

Third in line, is the form, size and outline of the apple, and also the core line.

Fourth in rank of inconsistency is the tube, while the stamens, apical and lower basins fluctuate least.

As far as could be observed there is very little fluctuation in shape, size or form of the calyz in any variety of apples.

In general, while there are no two apples exactly alike in any one variety, yet there is a certain similarity running through one variety that makes the apples look alike.

On the following pages is shown in percentages the amount of fluctuation of each variety along the various parts of the apples

The per cent indicated shows the per cent of fluctuation while the negative amount is the per cent of constancy.

In conclusion it might be said that the investigation, if it were continued with all the different varieties of apples that we have, would probably bring out the same facts as have been brought out in the study of these fifty varieties.

There is a slight possibility that where only one variety is grown in an orchard there may not be such a great tendency toward fluctuation of characteristics as there would be in an orchard like the State College of Washington orchard where there are hundreds of different varieties of apples.

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TABLE OF CONTENTS.

THE CLASSIFICATION OF PLANTS, VII.[1]

JOHN H. SCHAFFNER.

There can be little question as to the general importance of a correct taxonomy; for the views of all botanists, whether they deal directly with classification or not, must be more or less influenced by the scheme of supposed relationships which they follow. On the arrangement accepted must depend one's ideas of what are high and low plants, and this again must have its effect on one's views about derivation and evolution. Thus one finds the arguments advanced by various authors based very largely on the classification followed. The viewpoint must certainly be fundimentally different when, on the one hand, primitive forms are recognized in such remarkably specialized trees as Casuarina, or, on the other, in a general type like Magnolia.

Ecological adaptations must be explained on the same basis. One must determine whether anemophilous and hydrophilous flowering plants are the more primitive or those that are entomophilous; whether the bisporangiate or monosporangiate flowers represent the original type; whether vestigial organs are to be regarded as being derived from normal ones and thus as indicating lines of evolution.

When a correct series is established, there is often a remarkable parallelism between the evolutionary development and specialization of the flower and the completeness of the ecological adaptation. Thus in the lowest Alismales the plants are aerial with showy bisporangiate flowers having numerous parts in spirals and usually possessing nectar glands, while the most specialized species are completely aquatic with reduced monecious or diecious flowers without perianth and with hydrophilous pollination.

1. Contributions from the Botanical Laboratory of Ohio State University, 64.

Such a sequence can be traced more or less completely in other hydrophytic groups.

Anemophily has also been developed independently in numerous groups; nearly always accompanied by the monosporangiate condition, loss of part or all of the perianth, and general reduction of the flower and the inflorescence.

Peculiar morphological conceptions of development are frequently formulated on the basis of an improper taxonomy, and transformations and re-creations are either tacitly or openly advocated, the acceptance of which would require a credulity greater than a belief in an innumerable series of special creations. Even the interpretation of the geological history of plants depends somewhat on our scheme of classification; since the geological history of plants, so far deciphered, is exceedingly incomplete and must still be interpreted through the morphology of living species.

Three general systems of plant classification have been in vogue: (1) the artificial system, (2) the so-called natural system, and (3) the phyletic or evolutionary system. For the larger groups, the old natural system is still largely in use, and in the detailed arrangements of genera and species, one can still detect much of the artificial method. The natural system was not based on evolutionary principles, and probably prevented many of its followers from accepting the doctrine of descent because of the impossible transformations which would have been required to obtain genetic continuity in the series of plant forms expressed in the classifications of the time.

To reconstruct classification on a phyletic basis will require much shifting, not only of the larger phyla and classes but also of orders, families, genera, and species. But we may safely formulate a principle of procedure which, although not always giving final results at present, will eventually lead to a true "natural" classification and will give us a more or less reliable presentation of the evolutionary history of the plant kingdom.

In tracing derivative relationships between two groups of plants, one of the essential considerations is the possibility of the transformation of the structures of the one into the other. Every morphological structure of the entire organism must be reasonably derived from some ancestral type, and the fact kept constantly in mind that one organ may be evolving or specializing rapidly while another is undergoing little change. In discussions of this nature carried on by those who do not follow the phyletic idea but divide plants arbitrarily by some more or less constant peculiarity, which may or may not indicate relationship, the result often becomes so artificial that whole groups of normal organs are derived bodily from the most extreme vestiges. So long as we do not see the course of evolution proceeding from vestigial

to normal organs it is not necessary to give much weight to such results. In the higher plants vestiges are exceedingly abundant and give a plain index to the course of phylogenetic development. Derivations or supposed relationships are also frequently based on *assumptions* from isolated morphological peculiarities which can be explained equally well on other *assumptions* that will not require the complete re-creation of the species from its supposed ancestor.

The basis of a modern taxonomy must at all events include the following principles:

1. The comparative study of the organography and anatomy of plants, proceeding from the simple to the more complex.
2. The definite recognition of primordia and transformations on the one hand and of vestiges on the other.
3. A study of incepts, embryological developments and juvenile forms.
4. The investigation of lines of degeneration and specialization, in both low and high types, leading from complex to simple structures.
5. The segregation of the units into genetically or phylogenetically related groups.
6. The arrangement of the branches thus segregated into series extending from the lowest and least differentiated to the most highly specialized.
7. In a word, the whole scheme of classification must show the result which has come about through progressive evolution, segregation, degredation, and specialization.

In the sixth article of this series of papers, an arrangement of the orders and families of Anthophyta found in the Northeastern United States was given. Since then the scheme has undergone some slight change in the writer's hands. It is believed that after this no important changes need be made for some time except perhaps the transfer of a few families after a wider knowledge of them is gained. The changes are as follows:

Transfer the Limnanthaceae to the Geraniales following the Oxalidaceae.

Interchange the subfamilies Melanthatae and Liliatae, placing the latter as the lowest group of the Liliaceae.

Divide the Hydrangeaceae into two subfamilies, Philadelphatae and Hydrangeatae.

Following the order, Saxifragales, insert the order Thymeleales including in sequence the families, Lythraceae, Thymeleaceae, Elaeagnaceae.

A preliminary synopsis is now given of the subclasses and orders of the Anthophyta. It is hoped that this may present a better view of the phyletic classification as applied to the higher plants and stimulate to further study.

The Alismales and Ranales lead in the two classes, Monocotylae and Dicotylae. The Helobiae do not represent the most primitive leaf and stem arrangements because of numerous hydrophytic adaptations. These adaptations are, however, direct modifications of primitive types. But the flowers in the lowest Alisimales and Nymphacales are by far the most primitive to be found among Monocotyls. However, the frequent dichotomous venation of certain species is very suggestive of primitive seed plants and ferns. The more primitive leaf and stem arrangements to be found among the Monocotyls are preserved in such groups as the palms, screw-pines and yuccas.

Following the synopses, a complete classification is given of the phyla, classes and subclasses, with a slight improvement over the schemes published in former papers.

Synopsis of the Subclasses and Orders of Anthophyta.

HELOBIAE.

Usually aquatic or marsh herbs with hypogynous or epigynous, actinomorphic, spiral or cyclic, bisporangiate or monosporangiate flowers; flowers solitary, axillary, racemose, or occasionally closely clustered; perianth frequently with prominent corolla, sometimes undifferentiated, vestigial or absent; carpels in the lower forms numerous and free, in the higher few and united; sperms in the pollengrain two.

Synopsis.

I. Flowers hypogynous or somewhat perigynous; carpels free or united, spiral or cyclic.
  1. Plants normal, with chlorophyll.
    a. Hypocotyledonary expansion, if present not lobed or only slightly notched; ovules usually anatropous or campylotropous; leaves often narrow, not peltate and not with a narrow basal sinus but sometimes sagitate, or deeply cordate. **Alismales.**
    b. Hypocotyledonary expansion parted into two lobes or deeply notched; ovules orthotropous; aerial or floating leaves peltate, with a deep basal sinus, or if somewhat sagitate then with carpels numerous and united. **Nymphaeales.**
  2. Small yellowish or reddish phagophytes. **Triuridales.**

II. Flowers epigynous; carpels united, cyclic. **Hydrocharitales.**

SPADICIFLORAE.

Trees, herbs, or climbing plants, usually with clustered flowers; the inflorescence being a crowded panicle, spike or spadix, rarely reduced; flowers hypogynous, often monosporangiate, the perianth present or absent, not definitely differentiated into calyx and corolla and commonly inconspicuous; carpels 4–1, usually 3, free or united.

Synopsis.

I. Inflorescence not a typical spadix.
  1. Leaves usually plicate and more or less split at maturity.
    a. Carpels free or united, usually 3, forming a unilocular or plurilocular ovulary with one ovule for each carpel. **Palmales.**
    b. Carpels united; ovulary unilocular with numerous seeds on 2 or 4 parietal placentae. **Cyclanthales.**
  2. Leaves linear or sword-shaped, not plicate and not splitting at maturity; flowers monecious, spikate or capitate. **Pandanales.**

II. Inflorescence a fleshy spadix, with or without a spathe; or minute plants without leaves floating free, the flowers few or solitary on the modified stem. **Arales.**

GLUMIFLORAE.

Usually grass-like herbs or rarely woody plants with hypogynous, inconspicuous flowers; carpels united, with 3–1 stigmas; perianth of 6–2 chaffy segments, or none; inflorescence usually consisting of spikelets or spikes; endosperm mealy or starchy.

Synopsis.

I. Ovulary 3–1-locular; ovules solitary in the cavities, orthotropous, pendulous. **Restionales.**

II. Ovulary unilocular, 1-ovuled, ovules anatropous, erect or ascending. **Graminales.**

LILIIFLORAE.

Herbs, sometimes shrubs, lianas or trees, usually with prominent flowers, with showy petals or staminodes, hypogynous or epigynous, solitary or clustered; carpels 3 or sometimes 2, united; flowers pentacyclic and trimerous or some modification of this type, usually bisporangiate but occasionally monecious or diecious, actinomorphic in the lower and prominently zygomorphic in the higher types; endosperm mealy, fleshy, or horny, sometimes none.

Synopsis.

I. Flowers hypogynous, seeds with endosperm. **Liliales.**

II. Flowers partly or completely epigynous.
  1. Seeds with endosperm.
    a. Flowers mostly regular. **Iridales.**
    b. Flowers very irregular, usually zygomorphic. **Scitaminales.**
  2. Seeds without endosperm, very numerous and minute; flowers usually irregular and zygomorphic. **Orchidales.**

THALAMIFLORAE.

Herbs or woody plants with hypogynous, choripetalous or apetalous flowers, calyx commonly of distinct sepals and inserted, with the other parts of the flower, directly on the floral axis.

Synopsis.

I. Carpels many to one, spiral or cyclic, usually free or only slightly united; stamens usually numerous. **Ranales.**
II. Carpels more or less united, cyclic.
  1. Herbs with insectivorous leaves; carpels 5–3. **Sarraceniales.**
  2. Herbs or woody plants with normal leaves, not insectivorous.
    a. Carpels 2 or more with parietal placentae; perianth usually with an even number of segments, the flowers commonly isobilateral. **Brassicales.**
    b. Carpels mostly 5 or 3; stamens mostly 10 or 5, or a reduction from 10; ovules pendulous. **Geraniales.**
    c. Carpels many to 3, ovules few; stamens indefinite, monadelphous, branched or clustered, or by reduction separate and few; sepals valvate. **Malvales.**
    d. Carpels 2 or more, commonly with parietal placentae; stamens usually indefinite; sepals and petals usually 5, sepals imbricated or convolute. **Guttiferales.**

CENTROSPERMAE.

Mostly herbaceous plants with hypogynous syncarpous flowers; usually apetalous except in the lowest families; ovulary usually with a central basal ovule or with many ovules on a central placenta.

Synopsis.

I. Perianth present consisting of a calyx and corolla or of a calyx only.
  1. Embryo curved, coiled, or annular, fruit not an achene.
    a. Fruit a capsule, berry, or anthocarp; calyx present; corolla present or absent. **Caryophyllales.**
    b. Fruit a utricle; calyx present, corolla none. **Chenopodiales.**
  2. Embryo straight or nearly so; fruit an achene. **Polygonales.**
II. Perianth none or vestigial; ovules usually orthotropous. **Piperales.**

CALYCIFLORAE.

Perianth and stamens usually borne on a perigynous disk or hypanthium which is sometimes united with the ovulary; carpels free or united; calyx usually of united sepals, petals when present separate.

Synopsis.

I. Carpels free or united, spiral or cyclic.
  1. Endosperm usually little or none; leaves mostly with stipules; carpels spiral or cyclic, often reduced to one, usually free or only slightly united, with a few evident exceptions. **Rosales.**
  2. Endosperm present and usually copious; leaves usually without stipules; carpels cyclic, free or united, sometimes slightly epigynous. **Saxifragales.**

II. Carpels united, cyclic.
  1. Hypanthium tubular or urn-shaped, often constricted above and enclosing the ripe fruit; endosperm commonly little or none. **Thymeleales.**
  2. Receptacle developing a glandular, annular, or turgid disk which is somewhat united with the perianth or ovulary, endosperm present or none. **Celastrales.**
  3. Disk tumid, united with the perianth, sometimes reduced; endosperm usually none. **Sapindales.**

AMENTIFERAE.

Mostly trees or shrubs with hypogynous or perigynous flowers, commonly in aments or ament-like clusters; flowers mostly apetalous or naked, generally monecious or diecious.

Synopsis.

I. Flowers not in typical aments, often in pendant heads or ament-like spikes or clusters; usually monosporangiate.
  1. Leaves alternate or rarely opposite.
    a. Stamens alternate with the petals (when present), or numerous; perianth sometimes none. **Platanales.**
    b. Stamens mostly 4, opposite the usually 4 sepals.
      (a) Calyx not petaloid. **Urticales.**
      (b) Calyx petaloid; stamens usually united with the sepals. **Proteales.**
  2. Leaves whorled, reduced to scales, ovulary unilocular with two ovules. **Casuarinales.**

II. Flowers, at least the staminate ones, in aments, monosporangiate.
  1. Seeds not with a tuft of hairs, fruit a typical or modified nut, achene or samara; plants monecious or diecious.
    a. Fruit 2–or more–seeded, ovules with 1 integument. **Balanopsidales.**
    b. Fruit usually 1 seeded. **Fagales.**
  2. Seeds with a tuft of hairs at one end; several in the capsule; flowers diecious without perianth; leaves usually alternate. **Salicales.**

MYRTIFLORAE.

Epigynous plants usually with large showy flowers, with or without a prominent hypanthium; more commonly choripetalous, but sometimes sympetalous or completely apetalous; ovules commonly numerous.

Synopsis.

I. Fleshy usually prickly and spiny plants with jointed stems and reduced leaves; perianth segments usually very numerous. **Cactales.**

II. Herbs, shrubs or trees not spiny like the preceding; calyx-segments rarely more than 5.
  1. Petals usually present, choripetalous; sometimes apetalous or sympetalous.
    a. Flowers usually bisporangiate, placentae usually axile or apical, rarely basal. **Myrtales.**
    b. Flowers bisporangiate or monosporangiate; placentae usually parietal; mostly herbs or herbaceous vines. **Loasales.**
  2. Petals usually absent; if present either choripetalous or sympetalous.
    a. Ovulary with several cavities, usually 6-locular; herbs or vines. **Aristolochiales.**
    b. Ovulary unilocular; mostly parasitic herbs or shrubs. **Santalales.**

HETEROMERAE.

Low, often evergreen, shrubs, trees, or herbs usually with hypogynous flowers which are usually sympetalous but sometimes choripetalous; perianth usually regular or nearly so inserted on the floral axis; stamens united with the corolla or free, usually as many or twice as many as the corolla-lobes; carpels usually 5–3.

Synopsis.

I. Ovulary mostly unilocular and usually with a free central placenta; stamens opposite the petals or more numerous, united with the corolla, mostly herbs. **Primulales.**

II. Ovulary mostly 2 or more locular or with parietal placentae; herbs, shrubs, or trees.
  1. Stamens mostly free from the corolla, alternate with its lobes or twice as many; seeds minute; flowers bisporangiate, hypogynous, sometimes choripetalous. **Ericales.**
  2. Stamens united with the corolla, opposite its lobes or twice as many or more; seeds usually solitary or few, usually large; flowers hypogynous or sometimes epigynous, sometimes choripetalous. **Ebenales.**

TUBIFLORAE.

Herbs, shrubs, or trees with hypogynous, sympetalous, occasionally choripetalous or apetalous flowers; flowers normally tetracyclic, usually with two united carpels; stamens united with the corolla, as many as its lobes and alternate, or fewer.

Synopsis.

I. Corolla not scarious, nerved.
  1. Fruit usually a capsule, follicle, berry, drupe, or samara; carpels commonly several-to-many-seeded.
    a. Corolla regular; stamens usually of the same number as the corolla lobes.
      (a) Leaves alternate or opposite; ovularies not separating. **Polemoniales.**
      (b) Leaves usually opposite; ovularies frequently separating below, with a common style; if not separating, usually with two cavities or two placentae. **Gentianales.**
    b. Corolla mostly irregular or oblique; fertile stamens commonly fewer than the corolla lobes. **Scrophulariales.**
  2. Fruit indehiscent but usually splitting and forming 4 nutlets around the style; carpels 1–2–seeded. **Lamiales.**
II. Corolla usually scarious, nerveless; calyx and corolla 4-lobed. **Plantaginales.**

INFERAE.

Mostly herbs, occasionally shrubs, trees, or lianas, with epigynous, choripetalous or sympetalous, or rarely apetalous flowers; stamens usually as many as the petals or corolla lobes and alternate with them; carpels two or more, united; calyx often vestigial.

Synopsis.

I. Anthers separate.
  1. Corolla choripetalous; flowers usually in umbels or cymes. **Umbellales.**
  2. Corolla sympetalous. **Rubiales.**
II. Anthers, with few exceptions, united; corolla sympetalous.
  1. Flowers not in involucrate heads. **Campanulales.**
  2. Flowers in dense involucrate heads; gynecium of two, or rarely three, united carpels, unilocular; seed one. **Compositales.**

Phyla, Classes, and Subclasses of Plants.

Phylum I. SCHIZOPHYTA. Fission Plants.
  Class 1. Cyanophyceae. Blue-green Algae.
  Class 2. Glaucocysteae.
  Class 3. Schizomycetae. Fission Fungi.
  Class 4. Myxoschizomycetae. Slime Bactera.

Phylum II. MYXOPHYTA. Slime Molds.
  Class 5. Plasmodiophoreae. (?)
  Class 6. Myxomycetae.
    Subclasses, Acrasieae.
      Myxogastreae.

Phylum III. ZYGOPHYTA. Conjugate Algae.
  Class 7. Diatomeae. Diatoms.
  Class 8. Conjugatae.

Phylum IV. GONIDIOPHYTA. Zoospore Plants.
  Class 9. Pleurococceae.
  Class 10. Protococceae.
  Class 11. Archemycetae.
  Class 12. Hydrodictyeae.
  Class 13. Monoblepharideae.
  Class 14. Siphoneae. Tube Algae.
  Class 15. Conferveae.

Phylum V. PHAEOPHYTA. Brown Algae.
  Class 16. Phaeosporeae.
  Class 17. Cyclosporeae.
  Class 18. Dictyoteae.

Phylum VI. RHODOPHYTA. Red Algae.
  Class 19. Bangieae.
  Class 20. Florideae.

Phylum VII. CHAROPHYTA. Stoneworts.
  Class 21. Chareae.

Phylum VIII. MYCOPHYTA. Higher Fungi.
  Class 22. Zygomycetae.
  Class 23. Oomycetae.
  Class 24. Ascomycetae. Sack Fungi.
    Subclasses, Hemiasceae. Intermediate Sack Fungi.
      Aspergilleae. Tuber Fungi.
      Discomycetae.
      Discolichenes.
      Pyrenomycetae.
      Pyrenolichenes.
      Exoasceae.
      Deuteromycetae. Imperfect Fungi.
  Class 25. Laboulbenieae. Beetle Fungi.
  Class 26. Teliosporeae. Brand Fungi.
  Class 27. Basidiomycetae. Basidium Fungi.
    Subclasses, Protobasidiae.
      Hymenomycetae.
      Hymenolichenes.
      Gastromycetae.

Phylum IX. BRYOPHYTA. Mossworts.
 Class 28. Hepaticae. Liverworts.
 Class 29. Sphagneae. Bogmosses.
 Class 30. Andreaeae. Granite Mosses.
 Class 31. Musci. True Mosses.
 Class 32. Anthoceroteae. Hornworts.

Phylum X. PTENOPHYTA. Fernworts.
 Class 33. Filices. Ferns.
  Subclasses, Eusporangiatae. Primitive Ferns.
  Leptosporangiatae. Modern Ferns.
 Class 34. Hydropterides. Water-ferns.
 Class 35. Isoeteae. Quillworts.

Phylum XI. CALAMOPHYTA. Horsetails and Allies.
 Class 36. Equiseteae. Horsetails.
 Class 37. Calamariae (Fossil) Calamites.
 Class 38. Sphenophylleae (Fossil) Wedge-leaf Calamites.

Phylum XII. LEPIDOPHYTA. Lycopods and Allies.
 Class 39. Lycopodieae. Lycopods.
 Class 40. Selaginelleae. Selaginellas.

Phyllum XIII. CYCADOPHYTA. Cycads and Allies.
 Class 41. Pteridospermae (Fossil) Seed Ferns.
 Class 42. Cycadeae. Cycads.
 Class 43. Cordaiteae (Fossil). Cordaites.
 Class 44. Ginkgoeae. Maiden-hair-trees.

Phylum XIV. STROBILOPHYTA. Conifers and Allies.
 Class 45. Coniferae. Conifers.
 Class 46. Gneteae. Joint-firs.

Phylum XV. ANTHOPHYTA. Flowering Plants.
 Class 47. Monocotylae. Monocotyls.
  Subclasses, Helobiae.
  Spadiciflorae.
  Glumiflorae.
  Liliiflorae.
 Class 48. Dicotylae. Dicotyls.
  Subclasses, Thalamiflorae.
  Centrospermae.
  Calyciflorae.
  Amentiferae.
  Myrtiflorae.
  Heteromerae.
  Tubiflorae.
  Inferae.

THE BIRDS OF DARKE COUNTY, OHIO.

Vaughan MacCoughey.

The following is a list of the birds of the Darke County region, in southwestern Ohio. During the years 1902–1904, inclusive, while the author was a lad in High school, the observations leading to this list were made. His companions in many pleasant rambles were Mr. Robert Boice, deceased, and Mr. Walter Sawyer, and identifications by one were commonly checked by the other two.

Darke County is a distinctly agricultural region, a large portion of the land being under the plow. There are many scattered woodlands, and meandering meadow-land streams or "creeks". There are no coniferous forests, no marsh formations, and no "rough" lands worthy of mention.

The sequence and nomenclature is that of Chapman's Handbook of Birds of Eastern North America.

1. **Green-winged Teal,** Anas carolinensis Gmel. Seen April 4, 1903.
2. **Pintail Duck,** Dafila acuta (Linn). Seen Sept. 5, 1903.
3. **Lesser Scaup Duck,** Aythya affinis (Eyt). Seen Dec. 27, 1902.
4. **Canada Goose,** Branta canadensis (Linn). Seen April 29, 1903
5. **American Bittern,** Botaurus lentiginosus (Montag). First seen, April 27, 1903; May 6, 1904. Summer resident, April to September.
6. **Great Blue Heron,** Ardea herodias Linn. Seen April 2, 1904.
7. **Little Green Heron,** Ardea virescens Linn. First seen May 11, 1904. Summer resident, May to October.
8. **Virginia Rail,** Rallus virginianus Linn. Seen April 4, 1903.
9. **Sora Rail,** Porzana carolina (Linn). Seen Sept. 28, 1903.
10. **American Coot,** Fulica americana Gmel. Seen April 14, 1903.
11. **American Woodcock,** Philohela minor, (Gmel). Seen April 16, 1903; March 20, 1904.
12. **Wilson's Snipe,** Gallinago delicata (Ord). Seen April 28, 1903. March 24, 1904.
13. **Semipalmated Sandpiper,** Ereunetes pusillus (Linn). Seen April 29, 1903.
14. **Yellow-legs,** Totanus flavipes (Gmel). Seen April 30, 1903.
15. **Solitary Sandpiper,** Totanus solitarius (Wils). First seen April 29, 1903, 1904. Transient visitant April, May, and August, September.
16. **Spotted Sandpiper,** Actitis macularia (Linn). First seen May 7, 1903; May 11, 1904. Summer resident, May to September.

17. **Killdeer,** Aegialitis vocifera (Linn). First seen March 10, 1902; March 2, 1903; Feb. 29, 1904. Summer resident, March to November.
18. **Bob-White,** Colinus virgianus (Linn). Permanent resident.
19. **Mourning Dove,** Zenaidura macroura (Linn). Permanent resident, common, except in winter.
20. **Turkey Vulture,** Cathartes aura (Linn). First seen, March 20, 1904. Summer resident, March to October.
21. **Cooper's Hawk,** Accipiter cooperi (Bonap). Permanent resident.
22. **Red-tailed Hawk,** Buteo borealis (Gmel). Permanent resident.
23. **Pigeon Hawk,** Falco columbarius Linn. Seen Aug, 22. 1903.
24. **Sparrow Hawk,** Falco sparverius Linn. Permanent resident.
25. **Fish Hawk,** Pandion haliaetus carolinensis (Gmel). First seen, May 7, 1903; April 16, 1904. Summer resident, April to September.
26. **Short-eared Owl,** Asio accipitrinus (Pall). Seen Nov. 2, 1902.
27. **Barred Owl,** Syrnium nebulsoum (Forst). Seen April 12, 1902.
28. **Screech Owl,** Megascops asio (Linn). Permanent resident.
29. **Great Horned Owl,** Bubo virginianus (Gmel). Seen April 26, 1903.
30. **Yellow-billed Cuckoo,** Coccyzus americanus (Linn). First seen, May 21, 1904. Summer resident, May to Sept.
31. **Black-billed Cuckoo,** Coccyzus erythrophthalmus (Wils). First seen, May 17, 1902; May 7, 1903; May 23, 1904. Summer resident, May to September.
32. **Belted Kingfisher,** Ceryle alcyon (Linn). Permanent resident.
33. **Hairy Woodpecker,** Dryobates villosus (Linn). Permanent resident.
34. **Downy Woodpecker,** Dryobates pubescens (Linn). Permanent resident.
35. **Yellow-bellied Sapsucker,** Sphyrapicus varius (Linn). First seen, March 21, 1903; April 2, 1904. Transient visitant, March, April and September, October.
36. **Red-headed Woodpecker,** Melanerpes erythrocephalus (Linn). Permanent resident.
37. **Red-bellied Woodpecker,** Melanerpes carolinus (Linn). Permanent resident.
38. **Flicker,** Colaptes auratus (Linn). Permanent resident.
39. **Whip-poor-whill,** Antrostomus vociferus (Wils). Seen May 10, 1903.
40. **Night-hawk,** Chordeiles virginianus (Gmel). First seen, April 24, 1902; May 25, 1904. Summer resident, April to October.

41. **Chimney Swift,** Chaetura pelagica (Linn). First seen, April 19, 1902; April 11, 1903; April 16, 1904. Summer resident, April to October.
43. **Ruby-throated Humming-bird,** Trochilus colubris (Linn). First seen, May 7, 1903; May 11, 1904. Summer resident, May to September.
44. **Kingbird,** Tyrannus tyrannus (Linn). First seen, May 2, 1902; April 29, 1903; May 20, 1904. Summer resident, April to September.
45. **Great Crested Fly-catcher,** Myiarchus crinitus (Linn). First seen, May 18, 1902; May 4, 1903; May 24, 1904. Summer resident.
46. **Phoebe,** Sayornis phoebe, (Lath). First seen, March 14, 1903; March 20, 1904. Summer resident, March to October.
47. **Wood Pewee,** Contopus virens, (Linn). First seen, May 12, 1903; May 11, 1904. Summer resident, May to October.
48. **Least Flycatcher,** Empidonax minimus Baird. First seen, April 27, 1902; May 9, 1903. Summer resident, April to August.
49. **Horned Lark,** Otocorus alpestris (Linn). Winter visitant, November to April.
50. **Blue Jay,** Cyanocitta cristata (Linn). Permanent resident.
51. **Crow,** Corvus americanus Aud. Permanent resident.
52. **Bobolink,** Dolichonyx oryzivorus (Linn). First seen, May 12, 1903; May 11, 1904. Summer resident.
53. **Cowbird,** Molothrus ater (Bodd). First seen, April 23, 1902; March 14, 1903; April 4, 1904. Summer resident, March to October.
54. **Red-winged Blackbird,** Agelaius phoeniceus (Linn). First seen, April 12, 1902; March 13, 1903; March 8, 1904. Summer resident.
55. **Meadowlark,** Sturnella magna (Linn). Permanent resident.
56. **Baltimore Oriole,** Icterus galbula (Linn). First seen, April 23, 1902; April 28, 1903; April 25, 1904. Summer resident, April to September.
57. **Rusty Blackbird,** Scolecophagus carolinus (Mull). Transient visitant, September and October.
58. **Bronzed Grackle,** Quiscalus quiscala aeneus (Ridgw). First seen, March 1, 1902; March 16, 1903; April 4, 1904.
59. **Purple Finch,** Carpodacus purpureus, (Gmel). Winter visitant, October to April.
60. **English Sparrow,** Passer domesticus (Linn). Permanent resident.
61. **American Goldfinch,** Spinus tristis (Linn). Permanent resident.

62. **Vesper Sparrow,** Pooecaetes gramineus (Gmel). Summer resident, March to October. First seen, April 30, 1903; March 19, 1903; March 23, 1904.
63. **Grasshopper Sparrow,** Ammodramus savannarum passerinus (Wils). Seen May 13, 1904. Probably a summer resident.
64. **Lark Finch,** Chondestes grammacus (Say). First seen, March 26, 1903. Spring migrant, March and April.
65. **White-crowned Sparrow,** Zonotrichia leucophrys (Forst). First seen, May 15, 1902; May 12, 1903; May 10, 1904. Spring migrant, May.
66. **White-throated Sparrow,** Zonotrichia albicollis (Gmel). First seen, April 17, 1902; March 18, 1903; April 23, 1904. Migrant, March to May, and Sept.-Oct.
67. **Tree Sparrow,** Spizella monticola (Gmel). Winter resident, November to April.
68. **Chipping Sparrow,** Spizella socialis (Wils). First seen, March 22, 1902; March 21, 1903; March 26, 1904. Summer resident, March to September.
69. **Field Sparrow,** Spizella pusilla (Wils). Permanent resident.
70. **Junco,** Junco hyemalis (Linn). Winter resident, Oct. to April.
71. **Song Sparrow,** Melospiza fasciata (Gmel). Permanent resident.
72. **Lincoln's Sparrow,** Melospiza lincolni (Aud). Seen Nov. 6, 1903.
73. **Swamp Sparrow,** Melospiza georgiana (Lath). First seen, April 18, 1903. Migrant, April and September-October.
74. **Fox Sparrow,** Passerella iliaca (Merr). First seen, April 20, 1902; March 21, 1903; March 20, 1904. Migrant, March April and September-October.
75. **Townee,** Pipilo erythrophthalmus (Linn). In some years probably a permanent resident; my records show it present from February to November, inclusive.
76. **Cardinal,** Cardinalis cardinalis (Linn). Permanent resident.
77. **Indigo-bird,** Passerina cyanea (Linn). First seen, May 1, 1902; May 4, 1903; May 24, 1904. Summer resident, May to August.
78. **Dickcissel,** Spiza americana (Gmel). First seen, May 17, 1902; May 18, 1903; Spring migrant, May-June.
79. **Rose-breasted Grosbeak,** Habia ludoviciana (Linn). Seen September 17, 1903.
80. **Scarlet Tanager,** Piranga erythromelas Vieill. First seen, April 29, 1903; May 11, 1904. Spring migrant, April-May.

81. **Purple Martin,** Progne subis (Linn). First seen, April 18, 1902; April 19, 1903; April 10, 1904. Summer resident, April to August.
82. **Barn Swallow,** Chelidon erythrogaster (Bodd). First seen, May 2, 1902; May 2, 1903; April 29, 1904. Summer resident, April to September.
83. **Bank Swallow,** Clivicola riparia (Linn). First seen, April 30, 1903. Summer resident, April to September.
84. **Rough-winged Swallow,** Stelgidopteryx serripennis (Aud). First seen, May 19, 1902; April 29, 1903; April 30 1904. Summer resident, April to September.
85. **Cedar Wax-wing,** Ampelis cedrorum (Vieill). First seen, May 21, 1902; April 14, 1903; May 24, 1904. Summer resident, April to October.
86. **Loggerhead Shrike,** Lanius ludovicianus Linn. First seen, March 23, 1902; March 22, 1903; March 23, 1904. Summer resident, March to September.
87. **Red-eyed Vireo,** Vireo olivaceus (Linn). Fall migrant, September.
88. **Philadelphia Vireo,** Vireo philadelphicus (Cass). Very rare fall migrant; September.
89. **Warbling Vireo,** Vireo gilvus (Vieill). First seen, April 28, 1903; May 11, 1904. Summer resident, April to Sept.
90. **Yellow-throated Vireo,** Vireo flavifrons Vieill. First seen, May 7, 1903. Summer resident, May to September.
91. **White-eyed Vireo,** Vireo noveboracensis (Gmel). Seen May 12, 1904.
92. **Black and White Warbler,** Mniotilta varia (Linn.) First seen, May 1, 1902; May 4, 1903. Migrant, May and September.
93. **Blue-winged Warbler,** Helminthophila pinus (Linn). First seen, April 28, 1903; April 29, 1904. Migrant, April-May and September.
94. **Yellow Warbler,** Dendroica aestiva (Gmel). First seen, May 1, 1902; April 18, 1903; April 23, 1904. Spring migrant, April-May.
95. **Black-throated Blue Warbler,** Dendroica caerulescens (Gmel). First seen, May 4, 1903. Migrant, May and Sept-Oct.
96. **Yellow-rumped Warbler,** Dendroica coronata (Linn). First seen, April 26, 1903; May 20, 1904. Migrant, April-May and Sept.-November.
97. **Magnolia Warbler,** Dendroica maculosa (Gmel). First seen, May 15, 1902; May 11, 1904. Migrant, May and August.
98. **Chestnut-sided Warbler,** Dendroica pennsylvanica (Linn). Seen September 20, 1903.

99. **Blackpoll Warbler,** Dendroica striata (Forst). Seen May 11, 1904.
100. **Blackburnian Warbler,** Dendroica blackburniae (Gmel). First seen, April 29, 1903. Migrant, April and Sept.
101. **Black-throated Green Warbler,** Dendroica virens (Gmel). First seen, October 12, 1902; September 20, 1903. Migrant, September-October.
102. **Yellow Red-poll Warbler,** Dendroica palmarum hypochrysea Ridg. Seen May 3, 1903.
103. **Oven-Bird,** Seiurus aurocapillus (Linn). Seen only in September.
104. **Water-Thrush,** Seiurus noveboracensis (Gmel). First seen, May 17, 1903. Seen only in May.
105. **Louisiana Water-Thrush,** Seiurus motacilla (Vieill). Seen May 11, 1904.
106. **Kentucky Warbler,** Geothlypis formosa (Wils). First seen, September 13, 1903. Seen only in September.
107. **Maryland Yellow-throat,** Geothlypis trichas (Linn). First seen, April 27, 1902; April 29, 1903; April 29, 1904. Summer resident, April to September.
108. **Yellow-breasted Chat,** Icteria virens (Linn). First seen, May 1, 1902; May 9, 1903; May 11, 1904. Seen only in May.
109. **Canadian Warbler,** Sylvania canadensis (Linn). Seen May 11, 1904.
110. **American Redstart,** Setophaga ruticilla (Linn). First seen, May 4, 1903; May 11, 1904. Migrant, May and Sept.
111. **American Pipit,** Anthus pensilvanicus (Lath). First seen, October 4, 1902. Seen only in October.
112. **Catbird,** Galeoscoptes carolinensis (Linn). First seen, April 27, 1902; April 29, 1903; April 28, 1904 Summer resident, April to October.
113. **Brown Thrasher,** Harporynchus rufus (Linn). First seen, April 17, 1902; April 4, 1903; April 5, 1904. Summer resident, April to September.
114. **Carolina Wren,** Thryothorus ludovicianus (Lath). Permanent resident, uncommon in winter.
115. **Bewick's Wren,** Thryothorus bewickii (Aud). First seen, May 18, 1902. Summer resident, May to October.
116. **House Wren,** Troglodytes aedon Vieill. First seen, May 1, 1902; April 4, 1903; April 2, 1904. Summer resident.
117. **Winter Wren,** Troglodytes hiemalis Vieill. First seen, March 19, 1903; April 5, 1904. Recorded in March, April, May, September, October.
118. **Short-billed Marsh Wren,** Cistothorus stellaris (Licht). One record, April 1902.

119. **Long-billed Marsh Wren,** Cistothorus palustris (Wils). One record, October 11, 1902.
120. **Brown Creeper,** Certhia familiaris americana (Bonap). Winter resident, October to April.
121. **White-breasted Nuthatch,** Sitta carolinensis Lath. Permanent resident.
122. **Red-bellied Nuthatch,** Sitta canadensis Linn. Migrant April and September-October.
123. **Tufted Titmouse,** Parus bicolor (Linn). Permanent resident.
124. **Chickadee,** Parus atricapillus (Linn). Permanent resident, most abundant, September to May.
125. **Golden-crowned Kinglet,** Regulus satrapa Licht. First seen, March 19, 1903; March 29, 1904. Migrant, March, and April, October and November.
126. **Ruby-crowned Kinglet,** Regulus calendula (Linn). First seen, April 18, 1903. Migrant, April.
127. **Blue-gray Gnatcatcher,** Polioptila caerulea (Linn). First seen, May 17, 1902; April 14, 1903; May 11, 1904. Migrant, April-May and September.
128. **Wood Thrush,** Turdus mustelinus Gmel. First seen, May 31, 1904. Migrant, May and September.
129. **Veery,** Turdus fuscescens Steph. First seen, April 7 1903; May 11, 1904. Spring migrant, April-May.
130. **Olive-backed Thrush,** Turdus ustulatus swainsonii (Cab). First seen, May 10, 1904. Migrant, May-June and September.
131. **Hermit Thrush,** Turdus aonalaschkae pallasii (Cab). First seen, April 3, 1903; April 17, 1904. Migrant, April-May and September-October.
132. **Robin,** Merula migratoria (Linn). Permanent resident, uncommon in December and January.
133. **Blue-bird,** Sialia sialis (Linn). Permanent resident; uncommon in December and January.

In all cases dates given are inclusive. **First seen** means the first record of the year for the species mentioned. Unfortunately, my records do not contain the dates of departure for migratory species.

It should be distinctly understood that the above records are those of a lad interested in bird-lore, rather than the field-results of a mature and experienced ornithologist. The determinations were all made in the field, with the aid of opera-glasses.

The College of Hawaii, Honolulu.

OHIO GROWN PERILLA.

CHAS. P. FOX.

The Perilla plant is an indigenous Labiatae of China, Japan and India. Several varieties of *Perilla nankensis* are grown as ornamental plants. *Perilla ocimoides* is not an ornamental plant, but is grown to a large extent in Japan and China for its oil. Perilla ocimoides is a tall, rough plant with square, much branched stems, simple, ovate leaves of light green. Blooms in September. Flowers, small, white, blotched with purple, numerous, in compact spike. Seeds ripen soon after flowering. Perilla seeds are 1-16 inch in diameter, irregular, about the same color, and much resemble those of the radish. They have a pleasant, slightly sweet, oily taste. Outer surface of seed reticulated. All portions of the plant contain a volatile oil or camphor, with strong minty odor.

The seed contains a fixed oil similar in taste, odor and drying qualities to our common linseed oil. In Manchuria, this oil is used for edible purposes. In Japan, the drying qualities of the oil are utilized in waterproofing paper umbrellas, in the manufacture of paints, varnishes and lacquers, in making transparent paper for windows, and in fabricating artificial leather. Its use in manufacture of window paper is very important. Commercial name of this oil is *Yo-Goma.*

In September, 1910, U. S. Consul Sammon, at Yokahama, Japan, reported on the uses of this plant and suggested its introduction into the United States. According to this report, (Daily Trade Reports, Bureau of Manufactures, Sept. 14, 1910), the plant thrives on the sandy soils of the colder portions of Japan and China.

In Japan, 300,000 bushels are produced annually. About 20 bushels per acre is the average yield. The oil is obtained by pressing, a bushel of seed producing a gallon of oil. The oil has a ready market at 35c per *sho* or 70c per gallon. The seed sells at 10c per pound.

Following the suggestion of Mr. Sammon, we imported, direct from Japan, early in 1911, a small quantity of this seed. Seed sown in mid April on the dry, sandy upland soil of West Akron. Its growth during the following summer, indicated that it is not a drought resisting plant. The plant develops, at an early date, a strong root system made up of many fine rootlets. These roots are surface feeders and, on this account, the plant is easily affected by dry weather. On moist, clayey soil the growth was much better. Estimates made on the basis of a small area gave a yield of 400 pounds of clean seed per acre. Our crop did not fill well. Only about 80% of the seed pockets contained a

1. Presented at the Twenty-first Annual Meeting of the Ohio Acad. of Sci., December 1, 1911, Columbus.

good sound seed. Many of the seeds were light. Compared with the original Japanese seed, Ohio grown seed is fully 19% lighter in weight per equal volume.

According to Lewkowitsch (Oils, Vol. 3, p. 38), Perilla oil occurs to the extent of 36% in the nutlets of Perilla ocimoides. In our own sample of Japanese perilla, we found, by extraction with benzol, 45% oil. Ohio grown perilla from same seed, by the same method, gave 41% oil. Ohio grow perilla oil is much darker and thinner than oil of Japanese origin, and when first extracted retains the strong odor of the growing plant.

Perilla oil when exposed to warm air, drys rapidly to a film. In Japan, the boiled hot oil is applied by means of brush or cloth, to the common paper sun shades and the treated articles exposed to the sun for five hours.

The drying qualities of perilla oil is said by authorities to be inferior on account of the tendency of the oil to gather in drops during the spreading operation. We do not find this to be the case. Japanese perilla oil and linseed oil agree very closely in their spreading qualities. In their drying qualities they differ, linseed oil drying much faster. Perilla oil, however, gives a smooth film. Films are equal in toughness and strength.

With paper, duplication of Japanese umbrella test, linseed shows to the better in giving a perfectly dry coating in much shorter time than perilla. Quality of coatings practically the same. In the same test, Japanese oil gave better results than the Ohio oil. This poor showing may be due to the newness of the seed. Old flaxseed oil or tanked linseed oil dries much better than new oil. Ohio oil, however, is much more fluid than oil of Japanese origin. This, also, may be due to the presence of the natural stearoptenecor perilla camphor found in the fresh plant.

Compared with flax, the crop with which it will compete, we get this data: An acre of flax yields 9 bushels or 504 pounds of seed containing 176.4 pounds (22.6 gallons) of oil, making, at 90c per gallon, an oil value of $20.34 per acre. To this must be added the returns from two valuable by-products, oil-cake and fibre.

An acre of perilla will give 400 pounds of seed containing 164 pounds (21.3 gallons) oil, making, at 70c per gallon, an oil value of $15.61 per acre. Perilla stems are worthless for fibre or fodder, and the value of the press cake for cattle food or fertilizer is unknown. It is possible that the cake residue could be directed towards a supply of bread stuff and that the essential oil or camphor could be obtained on the same lines as the peppermint oil industry. Assuming that the cost of production is the same, and that other conditions are equal, facing a loss of $4.73 per acre, it is hardly probable that this new crop will supplant flax as an Ohio crop. On the other hand, the argument presented points to the substitution of flax for perilla in Japanese agriculture and in the old opium fields of the new Chinese Republic.

Akron, Ohio.

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THE ARNHEIM FORMATION WITHIN THE AREAS TRAVERSED BY THE CINCINNATI GEANTICLINE.

By AUG. F. FOERSTE.

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1. Subdivisions of the Arnheim.

Along the eastern line of outcrop of the Ordovician formations in Kentucky, and in the immediately adjacent parts of Ohio, the lower part of the Arnheim member of the Richmond is comparatively unfossiliferous, while the upper part is abundantly supplied with fossils. The transition is sufficiently abrupt to be traced readily in the field. In fact, the line of separation between the lower, comparatively unfossiliferous division and the upper richly fossiliferous part of the Arnheim may be traced more readily, with greater exactness, and for a greater distance than any other horizon in the Richmond along its eastern line of outcrop. For this reason, the line of separation between the upper and lower Arnheim is more definitely known than any other horizon in the Richmond of eastern Kentucky, and it has been found convenient

to give special designations to these divisions; the upper Arnheim being called the *Oregonia* division, and the lower Arnheim, the *Sunset* division.

The ease with which the two divisions of the Arnheim may be traced is due largely to the fact that the Oregonia division includes a characteristic fauna which may be identified readily even by a beginner in the study of fossils. This fauna includes *Dinorthis carleyi*, *Rhynchotrema dentata* var., *Leptaena richmondensis* va and *Platystrophia ponderosa*.

In Ohio and Indiana *Dinorthis carleyi* recurs in a slightly different form at the base of the Blanchester division of the Waynesville member; *Rhynchotrema dentata* is found in the Blanchester division of the Waynesville member and near the upper part of the Whitewater member; and *Leptaena richmondensis* ranges from the Clarksville division of the Waynesville to the top of the Whitewater. But none of these fossils is found associated with *Platystrophia ponderosa* anywhere except in the lower part of the Oregonia division of the Arnheim. It is this association of fossils which gives them such great value as horizon markers. Moreover, if attention be confined to Kentucky, then *Dinorthis carleyi* and *Rhynchotrema dentata* here occur only in the Oregonia division, and within this limited territory they are strictly characteristic of the upper Arnheim.

TABLE OF SUBDIVISIONS OF CINCINNATIAN STRATA.

		Elkhorn	
		Whitewater	
		Saluda	
		Liberty	
Richmond	Laughery	Waynesville	
			Blanchester
			Clarksville
			Fort Ancient
	Arnheim	Arnheim	
			Oregonia
			Sunset
	McMillan	Mount Auburn	
		Corryville	
Maysville		Bellevue	
	Fairview	Fairmount	
		Mount Hope	
Eden	Eden	McMicken	
		Southgate	
		Economy	
		Fulton	
Catheys	Catheys	Nicholas	
		Greendale	

2. Eastern Kentucky, from Maysville to Stanford.

Platystrophia ponderosa ranges from the middle Fairmount to the base of the Richmond. Alone ,it does not designate any special horizon within this large vertical range, unless advantage be taken of some of the slight variations in form which may be recognized at certain horizons. However, associated with any of the other fossils mentioned above, it at once designates the Oregonia division of the Arnheim.

At weathered exposures, the upper or Oregonia division usually is represented by a limestone rubble. This term is used to designate a mass of small, irregular limestone fragments. The limestones from which the fragments are derived are thin, their upper and lower surfaces frequently are irregular, they are more or less penetrated by argillaceous material, and they break readily, especially along the surfaces of the included fossils. Some layers consist chiefly of entire shells and large fragments of fossils embedded in a matrix of clay which is somewhat more indurated than the clays immediately above and below. This induration is due to a greater lime content, probably owing to the imbedded fossils which may have given up part of their lime to the infiltrating waters. On weathering, these layers are reduced to a mass of fossils, partly free, but largely attached to one another more or less irregularly at their surfaces of contact. These masses of free fossils, of fossils partly cemented together by lime or indurated clay, and of irregular fragments of limestone are very characteristic of the upper or Oregonia division of the Arnheim.

The lower or Sunset division of the Arnheim presents a very different lithological appearance, but this appearance varies along the line of exposure.

At the deep railroad cut three miles southeast of Maysville, in Kentucky, the Sunset division, 16 feet thick, consists chiefly of comparatively unfossiliferous argillaceous limestone layers interbedded with clay. The limestone layers usually are several inches thick, they are of rather even texture, and their upper and lower surfaces are not conspicuously irregular. They, therefore, do not wear into a rubble, as in the case of the upper division of the Arnheim.

Northward, in Ohio, the quantity of clay interbedded with the limestones of the lower division of the Arnheim increases, fossils become fairly numerous, some of the limestone layers are distinctly less argillaceous, and the strata forming the upper and lower divisions of the Arnheim are less readily distinguishable, except by means of their fossil content, the species of *Platystrophia*, *Leptaena*, *Rhynchotrema*, and *Dinorthis*, mentioned above, occurring at the base or in the lower part of the upper or Oregonia division of the Arnheim.

South of Maysville, however, the lithologic differences between the upper and lower Arnheim become even more striking.

About a third of a mile southwest of Sunset, and two miles southwest of Hillsboro, in Fleming county, Kentucky, the Sunset division, 13 feet thick, consists of a rather uniform section of dense, argillaceous, dark blue limestone, nearly unfossiliferous, but containing a few specimens of *Platystrophia ponderosa* about three feet below the top. The overlying Oregonia division contains considerable clay, interbedded with fossiliferous limestone which has weathered into a limestone rubble.

East of Wyoming, four miles south of Sunset, the lower Arnheim, 15 feet thick, presents the same lithological appearance as at Sunset. Occasional specimens of *Platystrophia ponderosa* occur at different elevations. A variety of *Leptaena richmondensis* and one of *Rhynchotrema dentata* are found at the base of the Oregonia division.

The dark blue argillaceous limestone phase of the lower or Sunset division of the Arnheim bed may be traced as far south as Howards Mill, five miles east of Mount Sterling, Kentucky. East of the mill, it is 18 feet thick and contains occasional specimens of *Platystrophia ponderosa* near the base. The overlying Oregonia division consists of rubble limestone with numerous bryozoans.

South of Howards Mill, the lower division of the Arnheim becomes more shaly and weathers into a more sandy rock. *Platystrophia ponderosa* disappears, southward, from the lower division but becomes more abundant in the upper division. Half a mile southwest of Howards Mill, the lower division, 14 feet thick, consists of rather unfossiliferous, brown, shaly, sandy rock, weathering to a sandy clay. In the overlying Oregonia division, *Rhynchotrema dentata* is rather rare and *Heterospongia subramosa* occurs. *Platystrophia ponderosa* is abundant.

At the mouth of the Red river, at Merritts Ferry, *Platystrophia ponderosa* is abundant in the lower 8 feet of the Oregonia division. *Leptaena richmondensis* is found at the base, and *Rhynchotrema dentata* occurs one foot above the base of this division. The top of the lower division is formed by a very fine grained, bluish limestone, containing small gasteropods, chiefly *Lophospira*. Traces of this limestone are found as far northward as Indian Fields, eight miles northeast of Merritts Ferry.

The same limestone, blue, fine grained, and containing gasteropods, occurs one mile east of College Hill, four miles south of Merritts Ferry. Here the upper layer of limestone is one foot thick, the lower layer is a foot and a half thick, and the underlying shaly part of the lower Arnheim has a thickness of 11 feet. In the Oregonia division, *Platystrophia ponderosa* is confined to a section about two feet thick, two feet above the base of the division.

At Cobb Ferry, 6 miles south of the mouth of the Red river, only the upper third of the shaly part of the lower Arnheim is exposed. The fine grained, blue limestones, with gasteropods, at the top of this division forms a section about 4 feet thick. In descending order this section consists of one foot of limestone, two feet of sandy shale with several thin limestone layers, and one foot of limestone, underlaid by the upper third of the characteristic shaly section. The Oregonia division here appears practically unfossiliferous.

East of the reservoir, two and a half miles east of Richmond, Kentucky, the shale bed forming the major portion of the lower or Sunset division of the Arnheim, is 11 feet thick. It is overlaid by very fine grained blue limestone, one foot thick; thin layers, poorly exposed, having a total thickness of two feet; and hard dense limestone, two feet thick, probably forming the top of the lower Arnheim division. The basal part of the Oregonia division consists of very dark shaly rock, one foot thick, This is overlaid by hard blue limestone, 4 feet thick, containing fossils; spalling clay rock, two feet thick; and light colored clay, bluish or greenish in tint, assumed to form the base of the Waynesville or the top of the Arnheim section. According to this interpretation, the thickness of the Oregonia division of the Arnheim here is about 7 feet.

The light colored clay, which occurs at the top of the Arnheim section east of Richmond, is seen also east of College Hill, where the thickness of the Oregonia division is estimated at 11 feet. At Merritts Ferry, there is a layer of light blue clay sixteen and a half feet above the base of the Oregonia division. At Ophelia, four miles north of Richmond, the light colored clay is 11 feet above the base of the Oregonia division. These data suggest a local thinning of the Oregonia division southward as far as Richmond, accompanied by a diminution of its fossils content.

North of Ophelia, only the upper part of the lower Arnheim division is well exposed. The lower part of the exposure, 5 feet thick, consists of rather shaly limestone. The immediately overlying part of the section, 4 feet thick, consisting of fine grained limestone more or less interbedded with clay shale, is regarded as forming the top of the lower Arnheim. Two of the component limestone layers contain small gasteropods. The lower part of the Oregonia division, six and a half feet thick, consists of rubble limestone, containing *Platystrophia ponderosa*, *Leptaena richmondensis*, and *Rhynchotrema dentata*. This more fossiliferous part of the section is overlaid by 4 feet of argillaceous strata containing *Stromatocerium* in the lower half.

Stromatocerium occurs in the upper half of the Oregonia division also at Merritts Ferry, at the mouth of the Red river. Here it is found 9 feet above the base of this division, above the richly fossiliferous horizon, and 7 feet below the top of the Arnheim.

Stromatocerium occurs also four and a half miles south of Paint Lick, or 15 miles southwest of Richmond. Here it occurs about 8 feet above the base of the Oregonia division. The richly fossiliferous part, containing *Platystrophia ponderosa* and *Leptaena richmondensis*, forms the lower five and a half feet of this division. The top of the lower Arnheim consists of fossiliferous dove colored limestone, 5 feet thick, representing the fine grained limestone layers containing gasteropods, as seen at Cobb Ferry, College Hill, and at the mouth of Red river. Below the dove colored limestone, the characteristic shale bed of the lower Arnheim, 13 feet thick, is found.

The unfossiliferous shaly layers, characteristic of the lower or Sunset division of the Arnheim, may be traced with confidence as far west as Stanford. At three localities along the southwestern border of Garrard county, the thickness of the shaly layers varies from 16 to 17 feet, and that of the overlying dove colored limestones, at the top of the lower Arnheim, from four to five and a half feet. These localities are: half a mile east of the northern end of Preachersville; three miles southeast of Lancaster, a few hundred yards west of the pike, along Gilbert creek; and two and a half miles southwest of Lancaster, west of the pike to Stanford. Farther westward, apparently, the shaly part of the lower Arnheim thins rapidly. Two miles northeast of Stanford, and also two and three-quarter miles north of Stanford, along the road to Lancaster, the thickness of the shaly section is reduced to 7 feet, the overlying dove-colored limestone, at the top of the lower Arnheim, measuring three and five feet respectively.

The territory between Stanford and the mouth of Red river may be regarded as representing a distinct phase of the Arnheim sedimentation. Within this territory the lower Arnheim is characterized by an unfossiliferous shaly rock overlaid by a thinner section of dove colored limestones. The basal part of the upper Arnheim division contains *Leptaena richmondensis* and *Rhynchotrema dentata*, the latter at a slightly higher elevation whenever a difference in elevation is noted. The overlying part of the upper Arnheim section usually is richly fossiliferous, and contains among other fossils rather numerous specimens of *Platystrophia ponderosa*. At the top of the Arnheim section there is a layer of light colored clay, one or two feet thick, frequently containing numerous specimens of bryozoans. This clay layer has been assumed to form the base of the Waynesville bed, but it may be necessary to revise this classification when the fauna is better known. It is probable that most of these features may be detected as far north as Howards Mill, in the eastern part of Montgomery county.

The territory from Montgomery county to Mason county, already described, includes another phase of Arnheim sedimentation. Here the lower Arnheim consists of a rather uniform

argillaceous limestone section containing few fossils, although occasional specimens of *Platystrophia ponderosa* are found. The shaly layers and the dove colored limestone are absent. *Platystrophia ponderosa* is not abundant in the upper Arnheim at any horizon, but specimens occur in moderate quantities at the base of this upper division. The exact horizon of the various fossils has not been worked out in all of this territory, but at Maysville, and northward, the *Platystrophia ponderosa* horizon is below, not above, the horizons containing *Leptaena richmondensis* and *Rhynchotrema dentata*.

3. Central Kentucky, from Stanford to Lebanon.

The most western locality in Lincoln county at which *Leptaena richmondensis* at present is known from the Arnheim is found by going from the center of Stanford three-quarters of a mile southward and then the same distance southwestward. The nearest point at which *Rhynchotrema dentata* is known, is four miles northeast of Stanford, three-quarters of a mile directly south of Gilbert Creek station. West of these localities there is a gap of 14 miles within which no specimens of *Leptaena* or *Rhynchotrema* are known in the Arnheim. Within this gap it has been found difficult to assign definite limits between the upper and lower divisions of the Arnheim, although a few data are known which may prove of assistance.

At the locality a mile and a quarter southwest of Stanford, already mentioned, it is possible to identify the light colored clay with bryozoans, at the top of the Arnheim; the richly fossiliferous zone containing *Platystrophia ponderosa* and forming the lower part of the upper or Oregonia division of the Arnheim; and the *Leptaena richmondensis* horizon at the base of this division. At the top of the lower or Sunset division of the Arnheim, dove colored limestones occur, and these contain a globular bryozoan, which has been called *Prasopora* in the field.

This globular bryozoan occurs three and a half miles southwest of Stanford, a mile south of the Turnersville pike, east of the former site of a creamery at the home of Katie Ador. Here the globular bryozoan is fairly common in massive argillaceous rock, 4 feet thick. The layers with *Hebertella*, and a species of *Platystrophia* near Pl. *clarksvillensis*, are regarded as equivalent to the light colored clay layer at the top of the Arnheim. It was not possible to assign a definite limit to the base of the Arnheim.

The same globular bryozoan occurs also on the hill northwest of McKinney; in the railroad cut south of Moreland; and north of Knob Lick branch, a mile south of Shelby City station. The significance of this globular bryozoan horizon can be best understood after an examination of some of the sections still farther west, at which *Leptaena* and *Rhynchotrema* again occur at the Arnheim horizon.

One of the most instructive sections in this connection is that exposed along the lower part of Walloway creek, opposite the home of J. W. Isaacs, in Marion county. The locality may be reached by going one mile west of Rileys station and then following a road southward almost two miles. The section is described in descending order.

Argillaceous nodules and globular bryozoan	1 ft. 10 in.
Interval with various fossils	3 ft. 6 in.
Richly fossiliferous horizon with *Platystrophia ponderosa*	6 ft. 6 in.
Leptaena richmondensis at various levels, but rare except at base.	5 ft. 6 in.
Argillaceous limestone, fossils few	3 ft. 6 in.
Large branching bryozoans resembling *Batostoma*	1 ft.
Same large bryozoans and the globular bryozoans resembling *Prasopora*	6 in.
Argillaceous limestone with the same large branching bryozoans	1 ft.
Argillaceous rock, fossils few	3 ft.
Dove colored limestone with *Platystrophia ponderosa*	5 ft.
Opposite home of J. F. Crews, remainder of section down stream not visited.	

In this section, the *Leptaena* horizon is regarded as the base of the upper or Oregonia division of the Arnheim. Globular bryozoans occur at two horizons; at the top of the Arnheim section, associated with argillaceous nodules; and a short distance below the *Leptaena* horizon in strata which may belong to the lower division of the Arnheim but whose exact stratigraphical equivalent can be determined only after further study. It is possible, for instance, that the lower Arnheim practically thins out west of Stanford. The two horizons for the *Prasopora* usually may be distinguished readily. At the upper horizon, argillaceous nodules frequently are present, and both the globular bryozoans and the nodules occur in a whitish or light colored clay which is regarded as the stratigraphical equivalent of the light colored clay at the base of the Waynesville section northeast of Stanford as far as the mouth of the Red river. This horizon is always above the highest layers containing *Platystrophia ponderosa*. The lower horizon with the globular bryozoan occurs at the top of a section consisting of dove colored limestones and usually is overlaid by a small section of strata containing *Platystrophia ponderosa*. Near the base of this upper *Platystrophia ponderosa* horizon, *Leptaena richmondensis* and *Rhynchotrema dentata* occur at numerous localities, but where the latter species are found, the globular bryozoan is not needed as a horizon marker.

The globular bryozoan has a fair distribution at both the upper and the lower horizon. At the upper horizon it occurs from the vicinity of Lebanon as far east as Scrubgrass creek southwest of Mitchellsburg in Boyle county, and a mile east of Harveyton, in Casey county. Southward it is known as far as Rush Branch, in the southeastern corner of Marion county. At the lower horizon, it is known at numerous localities southwest of

Rileys, in Marion county, and thence southward to Rush Branch and eastward to Gravel Switch in Marion county, and Ellisburg, in Casey county. At several localities, among these the one about a mile east of Harveyton, in Casey county, the globular bryozoan occurs apparently immediately above the horizon containing *Leptaena richmondensis* and *Rhynchotrema dentata*.

At most of the localities in Marion, Boyle, and Casey counties, at which *Leptaena richmondensis* and *Rhynchotrema dentata* occur, the latter are found about 16 to 18 feet below the top of the upper horizon at which the globular bryozoans, associated with the argillaceous nodules occur. Below the *Leptaena* horizon, within a moderate distance, dove colored limestones are found. Near Lebanon, these dove colored limestones occur sufficiently far below the *Leptaena* horizon to suggest their equivalence to strata elsewhere assigned to the upper Corryville. In the area between Hankla, in Boyle county, and the locality southwest of Stanford, within which *Leptaena richmondensis* and *Rhynchotrema dentata* are unknown, these dove colored limetsones appear to lie nearer the lower *Prasopora* or globular bryozoan horizon, suggesting a thinning of the lower Arnheim and the absence of the Mount Auburn along this axial region of the Cincinnati geanticline.

4. Western Kentucky, from Nelson to Trimble Counties.

Between Lebanon and Cox Creek, seven miles north of Bardstown, a total distance of 25 miles, the Arnheim horizon has not been studied. North of Cox Creek, on the pike to Mount Washington and Louisville, *Leptaena* is associated with *Plastytrophia ponderosa*. Seven miles farther northward, in the southwestern corner of Spencer county, between High Grove and Smithvillle *Leptaena richmondensis* and *Rhynchotrema dentata* occur in the Arnheim member. The exposures here are so evidently related lithologically to those near Mount Washington, in Bullitt county, about five miles farther, toward the northwest, that they will be discussed in the same relation.

Southwest of Mount Washington, along the pike to Smithville and Bardstown, the following section is exposed:

Argillaceous limestone with *Platystrophia ponderosa* and *Constellaria polystomella*	2 ft. 8 in.
Hard fossiliferous limestone forming a small fall near the home of F. C. Porter, where a fence crosses the creek	2 ft. 6 in.
Richly fossiliferous argillaceous rock with *Platystrophia ponderosa* a foot and a half from the top and with *Leptaena richmondensis* near the base	5 ft. 4 in.
Argillaceous rock and thin limestone, richly fossiliferous, with *Leptaena richmondensis* at various intervals. *Platystrophia cypha-conradi* occurs rather abundantly. *Rhynchotrema dentata* is present at the base, on the eastern side of the creek, where a wagon road crosses the creek near the level, 485 feet above sea	14 ft.

Interval with *Leptaena richmondensis* rather common in the upper part, the lowest specimens occurring near the home of J. D. Stansbury .... 10 ft.

Strongly cross bedded, rather coarse grained limestone layers, forming crescentic sweeps of strongly inclined limsetone laminae, striking in a general way North 40° West. The concave sides of these crescentic curves face the southwest. The length of the curves averages about 20 feet. The total thickness of this crossbedded section is not known; it can not be less than 6 feet and may equal .... 12 ft.

The base of the strongly cross-bedded section is directly east of the most northern farm house seen on the western side of the creek.

The most striking features of this section, southwest of Mount Washington, are: The presence of *Leptaena richmondensis* throughout a vertical range of 24 feet, with *Rhynchotrema dentata* near the middle of this range. The presence of *Platystrophia ponderosa* for a distance of 10 feet above the *Leptaena* horizon. This strongly cross bedded limestone is regarded as equivalent to the lower Arnheim elsewhere. It suggests the presence of shallow waters with strong currents and in this respect is in rather strong contrast with the exposures so far described. Possibly the thickness of the strata containing *Leptaena*, and the thickness of the underlying cross bedded limestone section have been greatly exaggerated, in attempting to estimate their thickness along the creek.

About two and a half miles southeast of Mount Washington, *Leptaena richmondensis* has a vertical range of 14 feet. *Platystrophia cypha-conradi* is common. *Dinorthis carleyi* occurs at the base. *Platystrophia ponderosa* occupies a section about 4 feet thick, at a distance 10 feet above the *Leptaena* horizon. Cross bedded limestones occur at the base of the Arnheim section, but some of the layers near the top also are coarse grained.

The greatest thickness of coarsed grained, cross bedded limestone at the base of the Arnheim section is seen about a mile northwest of High Grove, in the southwestern corner of Spencer county. Here it is 12 feet thick, and is immediately overlaid by strata containing *Leptaena richmondensis* and *Rhynchotrema dentata*. The vertical range of *Leptaena* has not been established here.

About a mile southeast of Smithville, along the pike to Bardstown, coarse grained limestone, 5 feet thick, occurs below layers containing *Leptaena richmondensis* and *Dinorthis carleyi*. Loose specimens of *Rhynchotrema dentata* also are found. The exact succession has not been established beyond doubt.

About a mile west of Smithville, on the north side of Salt river, the coarse grained limestone in the Arnheim section is about three and a half feet thick. *Platystrophia ponderosa* occurs at a higher level.

Near the home of Asa Lutes, southwest of the Grinwell ford, *Leptaena* is present within two feet above a cross bedded limestone containing *Platystrophia ponderosa.*

In this area including the eastern part of Bullitt county, the southeastern part of Jefferson county, and the adjacent parts of Spencer county, the Arnheim is more variable from exposure to exposure than in any other known area of equal size. This probably is due to shallow water conditions and current action.

About a mile west of Fisherville, *Dinorthis carleyi* is overlaid by strata containing *Leptaena richmondensis* and *Rhynchotrema dentata,* and the latter by layers containing *Platystrophia ponderosa.*

This is the most northern locality at which *Platystrophia ponderosa* is known to occur above the *Leptaena* horizon, on the western side of the Cincinnati geanticline. North of Fisherville, *Platystrophia ponderosa* is known only from below the *Leptaena* horizon. A similar succession is noted on tracing the Arnheim strata on the eastern side of the Cincinnati geanticline northward. As far as the mouth of the Red river and Howards Mill, *Platystrophia ponderosa* is found above the *Leptaena* horizon as well as in the underlying Maysville beds, but toward the Ohio river and northward, this species occurs only below the *Leptaena* horizon.

About a mile northeast of Pendleton, in Henry county, *Dinorthis carleyi* occurs immediately above a section, two feet thick, in which *Leptaena richmondensis* is common, but the latter species occurs also 6 feet farther up.

At Scott's Hill, in the eastern part of Trimble county, four miles east of Bedford, *Dinorthis carleyi* and *Leptaena richmondensis* occur in the Arnheim, and they occur also at Milton, on the Ohio river, with *Dinorthis carleyi* about two feet above the *Leptaena richmondensis* horizon.

5. Indiana.

Along the railroad in the northwestern part of Madison, Indiana, *Dinorthis carleyi* is rather common in a section about a foot and a half thick. *Leptaena richmondensis* occurs about four feet lower, and the horizon for *Platystrophia ponderosa* is seven and a half feet farther down.

Platystrophia ponderosa is not known in the Arnheim of Indiana anywhere north of Madison. *Leptaena richmondensis* is associated with *Dinorthis carleyi* about a mile southeast of Sparta, or eight miles west of Lawrenceburg; five miles east of Brookville, on Big Cedar creek; and a mile north of Brownsville or five miles northwest of Liberty. It is a comparatively rare fossil in Franklin and Union counties, however, and it has not been found at any locality between Franklin county and the Ohio river except at Madison. Even *Dinorthis carleyi* is comparatively rare in the area south of

Franklin county, although this is the only one of the fossils characteristic of the basal part of the upper or Oregonia division of the Arnheim which has a fairly general geographic distribution in the area designated. In most of this territory, the Arnheim consists of argillaceous limestone, and indurated clay layers interbedded with much larger quantities of soft clay. The lower Arnheim does not differ lithologically from the upper part.

The chief characteristic of the Arnheim in Franklin and Union counties, in Indiana, is the presence of a variety of *Dalmanella jugosa* in rather large numbers. Northwest of the home of William Bauman, two miles southwest of Brookville, *Dalmanella* has a considerable vertical range above the *Dinorthis carleyi* horizon. At New Trenton, Indiana, *Dalmanella* has a considerable vertical range below the *Dinorthis carleyi* layer; in fact, it occurs even as low as the Mount Auburn. North of Brookville, as far as the northern boundary of Franklin county, *Dalmanella* ranges from several feet above the *Dinorthis carleyi* horizon to at least 10 feet below that level.

6. Ohio.

Dalmanella has a considerable vertical range in the Arnheim also in the western half of Hamilton and Butler counties, in Ohio. Farther eastward, as far as Adams county, on the Ohio river, *Dalmanella* is restricted, in the Arnheim, to a vertical range of only a few inches, at or immediately above the *Platystrophia ponderosa* horizon, and distinctly beneath the *Leptaena richmondensis* and *Dinorthis carleyi* horizons. Wherever, at these more eastern localities, *Dalmanella* has a considerable vertical range, it is known to characterize the Waynesville member. The result is that, farther eastward, *Dalmanella* may be used to identify readily the Waynesville member, especially the lower part, where other conspicuous characteristic fossils are not common. while in the western part of Butler and Hamilton counties, and in Franklin county, this species may prove misleading if only a superficial study be given to a line of outcrops.

A most peculiar section, differing in some respects from any other known, occurs about a mile north of Collinsville, or eight miles northwest of Hamilton, Ohio. The top of the Arnheim is not exposed.

Nodular argillaceous limestone near the top of the Arnheim...	2 ft.	
Interval with *Byssonychia* and *Rafinesquina* common..........	11 ft.	6 in.
Clay with *Dalmanella* and with a single loose specimen of *Dinorthis carleyi* which may have come from this horizon..	3 ft.	6 in.
Clay and limestone. Topmost layer wave-marked...............	7 ft.	4 in.
Dalmanella abundant in clay and thin limestone.................	6 ft.	8 in.
Clay interbedded with limestone..................................	6 ft.	9 in.
Argillaceous rubble limestone....................................	2 ft.	9 in.
Highest *Leptaena richmondensis* horizon.		
Interval with *Platystrophia ponderosa* at various levels........	1 ft.	9 in.
Leptaena richmondensis.		
Interval..	1 ft.	8 in.
Platystrophia ponderosa just above creek level.		

Lithologically, the rock from the creek level as far up as the argillaceous rubble limestone above the highest *Leptaena* horizon resembles the rock forming the Mount Auburn member in most of Ohio and adjacent Kentucky. Moreover, there is a considerable interval between this part of the section and the *Dinorthis carleyi* horizon. However, *Leptaena richmondensis* is unknown in the Mount Auburn member from any of the numerous exposures where this horizon has been definitely identified. Hence, the Collinsville section may be merely an Arnheim exposure in which the interval between the *Platystrophia ponderosa* horizon and the *Dinorthis carleyi* horizon is represented by an unusual thickness of strata.

As a rule, *Leptaena richmondensis* occurs in the Arnheim of Ohio only a short distance below the *Dinorthis carleyi* horizon. The interval rarely exceeds five feet, and frequently is reduced to only a few inches.

At the Blacksmith hollow, a short distance north of the railroad station, at Oregonia, Ohio, six miles northeast of Lebanon, the following section is seen:

Massive nodular argillaceous limestone..................	5 ft.	6 in.
One specimen of *Strophomena concordensis*.		
Rubble clay rock with some argillaceous limestone............	15 ft.	
Dinorthis carleyi common..................		6 in.
Rubble clay rock with *Dinorthis* at various intervals............	5 ft.	
Rubble clay rock with *Rafinesquina*..................	1 ft.	
Dinorthis carleyi common and one specimen of *Leptaena richmondensis* in thin limestone.		
Interval..................		9 in.
Dinorthis carleyi, one specimen.		
Leptaena richmondensis common..................	1 ft.	6 in.
Rubble clay..................	1 ft.	6 in.
Platystrophia ponderosa rare.		
Rubble clay rock, with *Cyclonema humerosum*, *Rafinesquina loxorhytis*, and *Zygospira modesta*..................	12 ft.	
Interval not exposed..................	17 ft.	
Estimated level of base of Arnheim. No exposures here.		

A similar succession of strata is found near the home of G. W. Robertson, at the mouth of Lick run, opposite the mouth of Caesar creek, less than three miles north of Oregonia:

Nodular limestone, forming small falls.		
Interval..................	15 ft.	6 in.
Dinorthis carleyi at various intervals..................	6 ft.	
Leptaena richmondensis common..................		6 in.
Interval..................	3 ft.	6 in.
Strongly wave marked limestone layer, trend of ridges about north and south.		
Interval..................	3 ft.	
Platystrophia ponderosa rather common..................		4 in.

A similar succession of strata is seen three miles northeast of Goshen, at the middle part of the northern edge of Clermont

county. Here *Dinorthis carleyi*, *Leptaena richmondensis*, *Dalmanella jugosa*, and *Platystrophia ponderosa* are found in descending order.

The typical exposure of the Arnheim bed is located on Straight creek, about a mile south of Arnheim, and five miles northeast of Georgetown, in Brown county:

Strophomena concordensis near top of blue, nodular clay rock.	6 ft.	
Limestone interbedded with much clay	12 ft.	
Strongly wave-marked limestone.		
Limestone interbedded with clay	7 ft.	
Dinorthis carleyi rare.		
Thin limestones and clay, with *Leptaena richmondensis* and *Rhynchotrema dentata*		6 in.
Limestone and clay with *Leptaena richmondensis*		9 in.
Clay with layers of nodules	2 ft.	4 in.
Thin limestone with *Leptaena richmondensis* abundant		2 in.
Limestone and clay	5 ft.	
Platystrophia ponderosa abundant in limestone		8 in.
Dalmanella jugosa var., abundant, largest specimens 22 millimeters wide, associated with *Platystrophia ponderosa*, rather few		9 in.
Poorly exposed	7 ft.	
Coarse grained, cross bedded limestone, with wave-marked layer five inches above the base	5 ft.	6 in.
Limestone and clay interbedded	7 ft.	6 in.
Rafinesquina very abundant	4 ft.	6 in.
Limestone with bryozoans and other fossils	1 ft.	6 in.
Mount Auburn top, consisting of clayey limestone with *Platystrophia ponderosa* rather abundant	3 ft.	9 in.
Wave-marked limestone layer.		

At Eddies run, one mile east of the line between Brown and Adams counties, and about six miles west of West Union, the following section is seen:

Strophomena concordensis common in nodular clay rock	5 ft.	
Interval	18 ft.	6 in.
Leptaena richmondensis rare		4 in.
Interval	5 ft.	
Leptaena richmondensis abundant	1 ft.	
Interval	10 ft.	
Platystrophia ponderosa and *Dalmanella jugosa* var. associated in the same layers	1 ft.	

Half a mile east of Manchester, the Beasley fork pike to West Union crosses Island creek, and a mile northward the Mount Auburn bed is exposed. A quarter of a mile farther northward, northwest of the home of A. H. Foster, *Leptaena richmondensis* is exposed five feet above layers containing *Dalmanella jugosa var.* and *Platystrophia ponderosa*. *Strophomena concordensis* occurs farther up stream.

About three miles south of Maysville, in Kentucky, the deep cut at the highest point reached by the railroad exposes the following section:

Strophomena concordensis, associated with *Dalmanella jugosa* in bluish limestone	2 ft.	
Argillaceous limestone	16 ft.	
Dinorthis carleyi occurs somewhere in this argillaceous limestone section. Loose specimens have been found at various intervals between five and eight feet above the base of this argillaceous limestone, but, although the specimens are fairly abundant in the rock quarried out while making the cut, no specimens have been seen in place.		
Leptaena richmondensis abundant	1 ft.	
Rhynchotrema dentata belongs somwehere near this horizon since it occurs loose on the slopes below.		
Argillaceous limsetone	3 ft.	6 in.
Softer clay rock, weathering back	1 ft.	6 in.
Limestone		10 in.
Platystrophia ponderosa	2 ft.	4 in.
Dalmanella jugosa abundant, associated with *Platystrophia ponderosa*		6 in.
Argillaceous limestone interbedded with considerable clay, forming the Sunset division of the Arnheim	18 ft.	
Mount Auburn member.		

The presence of *Platystrophia ponderosa* and *Dalmanella jugosa* var. at the base of the upper or Oregonia division of the Arnheim may be detected throughout the Ohio area of exposure, although these fossils are common as a rule only in the more eastern exposures and are entirely absent at many of the western localities.

At Pisgah, ten miles southeast of Hamilton, the following section is seen:

Dinorthis carleyi fairly common	4 ft	
Dinorthis carleyi rare, associated with *Leptaena richmondensis*	2 ft.	
Interval	2 ft.	6 in.
Platystrophia ponderosa rare	2 ft.	

At Reileys, seven miles west of Hamilton, a thin horizon containing *Dalmanella* is overlaid by *Leptaena richmondensis*, and the latter by *Dinorthis carleyi.*

Along the railroad northwest of Bridgetown, seven and a half miles northwest of the center of Cincinnati, a single specimen of *Platystrophia ponderosa* was found just beneath *Leptaena richmondensis* and *Dinorthis carleyi.*

7. Nodular Top of Arnheim in Ohio.

The so-called nodular argillaceous limestone at the top of the Arnheim section in many parts of Ohio, is in reality not nodular at all, in the ordinary acceptance of this term. The limestone is irregular bedded and breaks up into lumps, so that the term lumpy limestone is more descriptive. It forms a very characteristic part of the Arnheim sections first studied, namely those near Lebanon and Oregonia, in Warren county, Ohio. Similar exposures occur at the southern edge of Montgomery county, opposite the Franklin Chautauqua. At Oregonia the thickness of this lumpy limestone is five and a half feet. North of Lebanon, it is four and

a quarter. At the Franklin Chautauqua, it is three feet. About four miles west of Middletown, or two and a half miles south of the southeastern corner of Preble county, the thickness of the massive argillaceous limestone at the top of the Arnheim section is two feet three inches. These data suggest a thinning of the lumpy limestone section westward, and indicate why it is so difficult to identify the so-called nodular limestone at the top of the Arnheim section still farther westward.

At the locality on the Dry fork of Elk run, four miles west of Middletown, the following section is seen:

Massive argillaceous, more or less lumpy, limestone	2 ft. 3 in.
Interval with *Anomalodonta gigantea*, *Rafinesquina loxorhytis*, and *Cyclonema humerosum* at various intervals	11 ft. 6 in.
Dinorthis carleyi	4 ft. 6 in.

The interval between *Dinorthis carleyi* horizon and the lumpy limestone may have been considerably greater than 12 feet since it was measured along the creek which here has a very low gradient.

Two and a quarter miles northwest of Hamilton, and also a mile southwest of McGonigle, or seven miles a little north of west from the center of Hamilton, the base of the Waynesville bed consists of very coarse grained, cross bedded limestone, five feet thick at the latter locality. In this limestone, *Dalmanella jugosa* is abundant. Southward from these localities, in the western parts of Butler and Hamilton counties, it is difficult to draw an exact line between the Waynesville and Arnheim beds, although the approximate position of this line is indicated by the first appearance of limestones with *Dalmanella*, which on weathering tend to take a reddish hue. The *Dalmanella* bearing beds at the Arnheim horizon appear not to be inclined to take this tint, and are more likely to change to yellowish or brownish colors.

Strophomena concordensis appears limited to the lumpy limestone horizon at the top of the Arnheim bed, but it is not known farther west than the southeastern part of Butler county, or farther north than Lebanon and Oregonia, in Warren county. Southeastward from these localities, *Strophomena concordensis* is found at practically every exposure of the top of the Arnheim as far as Maysville and Concord, in Kentucky. As a rule, the lumpy limestone section is about five feet thick, and *Strophomena concordensis* often ranges throughout the entire section. South of Arnheim, in Brown county, the lumpy limestone is about six feet thick, and the *Strophomena* occurs chiefly near the top. The lumpy argillaceous character of the limestone continues through Adams county nearly as far as the Ohio river. Three miles south of the Ohio river, at Maysville, *Strophomena concordensis* occurs in a limestone, weathering reddish and containing numerous specimens of *Dalmanella jugosa*, difficult to distinguish lithologically from the overlying Waynesville section.

Along the creek directly east of Concord, Lewis county, Kentucky, *Strophomena concordensis* is confined to an argillaceous rock, similar to the lumpy limestone, and a foot in thickness. This exposure is unique among all those known in Ohio, Indiana, Kentucky, and Tennessee, in containing *Streptelasma canadensis* and *Opisthoptera casei* five and a half feet below the *Strophomena concordensis* horizon, and *Streptelasma canadensis* and *Columnaria alveolata* five feet above this *Strophomena* layer.

The only other locality at which *Columnaria alveolata* is known from the Arnheim is at Clifton, on the Tennessee river, in western Tennessee, where it is associated with *Dinorthis carleyi*, *Rhynchotrema dentata*, *Leptaena richmondensis*, and a variety of *Dalmanella jugosa*.

8. Arnheim includes first advent of Richmond fauna.

The presence of *Strophomena concordensis*, *Streptelasma canadensis*, and *Columnaria alveolata* at the top of the Arnheim bed, at Concord, Kentucky, suggests the advent of the Richmond fauna. In fact, the nodular or lumpy limestone, at the top of the Arnheim section as originally defined, could with propriety be removed to the Waynesville member of the Richmond. However, *Leptaena richmondensis*, *Rhynchotrema dentata*, and *Dinorthis carleyi*, near the base of the upper or Oregonia division of the Arnheim, also suggest the advent of a Richmond fauna, and although limited to only a part of the Oregonia division, the latter also may be added to the Richmond section. The Sunset division is included in the Richmond only for the reason that southward, in Kentucky, it represents a period of diastrophic movement, the nearest thing to a sandstone sedimentation found in this part of the Cincinnatian section, and is regarded as inaugurating a new period of sedimentation rather than closing a former period. It is quite in keeping with this view, that northward, where no similar diastrophic movements are recorded, there should be no evidence of a faunal break sufficient to demand the separation of the lower or Sunset division of the Arnheim from the Mount Auburn member.

Before discussing this subject further, some of the more southern exposure of the Arnheim, in southern Kentucky, and in Tennessee, should be noted.

9. Adair County with nearest outcrops in Marion and Casey Counties, Kentucky.

The most southern localities, in the widespread Ordovician area including central and northern Kentucky, southwestern Ohio and southeastern Indiana, at which the characteristic fauna of the Arnheim has been found, occur along the South Fork of Rolling Fork. In the southeastern corner of Marion county,

about three-quarters of a mile southwest of Rush Branch postoffice, *Leptaena richmondensis* and *Rhynchotrema dentata* occur at the base of several feet of argillaceous limestone containing *Platystrophia ponderosa*. On the Steele Knob road from Chilton postoffice to Liberty, about a mile south of South Fork of Rolling Fork, near the northwestern edge of Casey county, *Leptaena richmondensis* occurs three feet below strata containing *Platystrophia ponderosa*.

Near the northeastern edge of Adair county, about a quarter of a mile south of the road from Dunnville to Neatsville, along Damron creek, twenty miles south of the localities on the South Fork of Rolling Fork, *Leptaena richmondensis* and *Platystrophia cypha-conradi* occur in the following section:

Greenish clay shale		7 in.
Irregular hard clay nodules		1 in.
Greenish clay shale		5 in.
Argillaceous limestone rubble interbedded with irregular indurated fossiliferous clay masses and considerable softer clay, containing *Leptaena richmondensis, Platystrophia cypha-conradi, Anomalodonta gigantea, Byssonychia radiata, Hebertella occidentalis* and other fossils	3 ft.	2 in.
Spalling clay rock	1 ft.	2 in.
Shaly material weathering into small fragments		5 in.
Argillaceous limestone		8 in.
Argillaceous rock, splitting into irregular thin layers and breaking up into small fragments owing to vertical cracks	6 ft.	
Interval, covered	4 ft.	6 in.
Damron Creek.		

Platystrophia ponderosa is exposed at a lower horizon, farther up the creek, in hard, fine grained, bluish limestone, apparently corresponding to the dove colored limestones below the Arnheim horizon in Lincoln, Garrard, and Madison counties, northward.

10. Western Tennessee.

Nearly a hundred miles southwest of Damron creek, nearly four miles north of Gallatin along the railroad toward South Tunnel, *Leptaena richmondensis* associated with *Platystrophia ponderosa* occurs at the Arnheim horizon in a section about 12 feet thick. In the lower half of this section consisting of argillaceous limestone, both species are common. In the upper part, consisting of more coarse grained limestone, only occasional specimens of *Leptaena* occur. At the very top of the section, small specimens of *Dalmanella* are found. *Platystrophia ponderosa* continues common for ten feet below the lowest strata at which *Leptaena* occurs.

Rhynchotrema dentata is common in the Arnheim eight miles northeast of Goodletsville, about ten miles west of Gallatin, in Tennessee. It occurs in the Arnheim, associated with *Dalmanella jugosa* var. and an occasional specimen of *Platystrophia ponderosa*,

also at Newsom, about 15 miles southwest of Nashville. At Clifton, on the Tennessee river, about 85 miles southwest of Nashville, *Rhynchotrema dentata* occurs associated with *Dinorthis carleyi*, *Leptaena richmondensis*, *Dalmanella jugosa* var., and *Columnaria alveolata*, at the Arnheim horizon.

The connection of these Arnheim localities in Tennessee with those in Kentucky is hidden at present by the covering of later rocks. This connection probably extended from the vicinity of Gallatin, in Tennessee, northward toward Bullitt county, in Kentucky. It is significant that the most southern exposures in Kentucky containing *Dinorthis carleyi* are in the northern part of Nelson county, on the western side of the Cincinnati geanticline, and in Mason county, on the eastern side. In the large series of exposures of the Arnheim, connecting these localities across central Kentucky, *Dinorthis carleyi* is unknown. Moreover, even *Leptaena richmondensis* and *Rhynchotrema dentata* disappear from the Arnheim along the axial part of the Cincinnati geanticline and along its eastern side long before reaching the Cumberland river in southern Kentucky.

11. Southern Kentucky along the Cumberland River.

Richmond strata, containing *Streptelasma*, *Stromatocerium*, and *Columnaria*, probably *Columnaria vacua*, are exposed along the Cumberland river, in the northern part of Wayne county, opposite the mouth of Forbush creek, and about a mile farther west, below the mouth of Little Cub creek. This horizon probably corresponds approximately to the base of the Liberty member of the Richmond, as exposed in central Kentucky. Farther down the river, the thin bedded strata, forming the Waynesville member, are exposed. Along the southern border of Russell county, at the northern end of the first bend made by the Cumberland river on reaching the county, a globular *Prasopora* and *Heterospongia subramosa* are present immediately above strata containing *Platystrophia ponderosa*. Stratigraphically, this *Prasopora* here occurs at the Arnheim horizon, but no diagnostic fossils were found. The same horizon is exposed again at Harmon creek shoals, about four miles farther down the river.

No specimens of *Prasopora* have been seen at the exposures below Creasy creek, below Indian creek, below Willis creek, or at any of the other exposures farther down the Cumberland river, in Kentucky, where strata equivalent to the Arnheim might be expected to occur.

12. Globular bryozoans in Casey and Lincoln Counties, Kentucky.

At Kidd's store, in Casey county, about eight miles northeast of Liberty, on the road to Hustonville, a globular bryozoan identified in the field as *Prasopora*, occurs at the Arnheim horizon,

above strata in which *Platystrophia ponderosa* is rare. It is important to remember that the globular bryozoan frequently referred to *Prasopora* in this discussion has not been subjected to microscopic investigation, so that its real affinities remain to be determined.

Northwest of Ellisburg, *Prasopora* occurs eleven feet below a light blue clay layer containing clay nodules. In the lower part of the intervening section, interpreted as upper Arnheim, *Platystrophia ponderosa* occurs. *Prasopora* is abundant on the hill supporting the stand-pipe northwest of McKinney, in Lincoln county; also along the railroad, a short distance south of Moreland. About a mile south of Shelby City, where the pike crosses Knob Lick branch, *Prasopora* occurs below strata containing *Platystrophia ponderosa*. The locality at the former site of the creamery, three and a half miles southwest of Stanford has been mentioned. All of these localities belong to the territory in which *Leptaena richmondensis* and *Rhynchotrema dentata* are absent. Even *Prasopora* is not present at all of the exposures regarded as belonging to the Arnheim horizon, at least approximately. In its absence, the identification of the Arnheim becomes difficult, in the territory under discussion.

Possibly the difficulty of identifying the Arnheim in some parts of Casey and Lincoln counties may be due to a thinning out of this member of the Richmond southeastward. This might account also for the disappearance of the *Leptaena* and *Rhynchotrema* fauna at all the more southern exposures in Kentucky, with the single exception of the exposure along Damron creek, in the northeastern corner of Adair county.

13. Diastrophic movements during deposition of the Arnheim.

The Arnheim period of deposition apparently began with a slight diastrophic elevation on the southeastern side of the Arnheim sea. This gave rise to the thin bedded, unfossiliferous, argillaceous strata forming a characteristic part of the Lower or Sunset division of the Arnheim, in Kentucky, from Lincoln county northward beyond the mouth of the Red river. It produced apparently the paucity of life in the argillaceous limestones forming the Lower Arnheim farther northward, from the vicinity of Howards Mill to the Ohio river at Maysville. Still farther northward, there was a sudden extinction of the great *Platystrophia ponderosa* colonies which characterized the Mount Auburn in many parts of Ohio. In Indiana, there is no evidence of any considerable change either in the character of the sedimentation or of the enclosed fauna on passing from the Mount Auburn to the Lower Arnheim.

Possibly the lower Arnheim thins out southward also on the western side of the Cincinnati geanticline, at least locally. The

coarse grained, more or less cross bedded limestones at the base of the Arnheim section, in the southern part of Jefferson county, in Kentucky, and thence southward to the northern part of Nelson county, suggest the presence of strong, irregular currents, but do not necessarily indicate an elevation of the sea bottom. These coarse grained limestones may represent in part the lower division of the Arnheim, east of the Cincinnati geanticline.

The sudden influx of *Leptaena richmondensis*, *Rhynchotrema dentata*, and *Dinorthis carleyi* during the deposition of the lower part of the upper or Oregonia division of the Arnheim, suggests the lowering of some barrier which for long geologic periods had kept any representatives of this group of species from Cincinnatian areas. The most astonishing feature of this faunal immigration is its great geographical range compared with its extremely short duration. What were the favorable conditions which in a brief time permitted this fauna to reach points as remote as southern Tennessee and southwestern Ohio? What were the unfavorable conditions which with equal suddenness caused the disappearance of this fauna? Where was the basin from which this fauna entered the Cincinnatian areas?

14. Origin of Arnheim faunas.

These questions are easier asked than answered. For instance, the general geographical distribution of *Dinorthis carleyi* in southwestern Ohio, southeastern Indiana, and western Kentucky, as far south as Nelson county, suggest its origin from some northern source, until it is remembered that this species occurs also at Clifton, in southwestern Tennessee. The northern origin of *Dinorthis carleyi* is favored also by the greater abundance of this species and by its greater vertical range in southwestern Ohio compared with its occurrence in southeastern Indiana, western Kentucky, or southwestern Tennessee. Moreover, the species attains a larger size and the valves are thicker as a rule in Ohio. In most of Kentucky, and at almost all localities in western Tennessee, from which the Arnheim is known, *Dinorthis carleyi* is absent. These facts suggest that the conditions were much more favorable for the growth of this species northwards, rather than southwards. As a matter of fact, however, the Arnheim is absent also along Lake Huron and Lake Ontario, and no trace of it has been recorded from Wisconsin or Minnesota on the northwest, nor from Pennsylvania or New York on the northeast. *Dinorthis carleyi* is so closely related to *Dinorthis retrorsa* from the Bala group of Wales that it certainly must be regarded as a derivative, but by what path did it enter Cincinnatian areas? Billings figured a specimen of *Dinorthis retrorsa* from the Trenton in the vicinity of Ottawa, in Canada, but this species is not mentioned by Dr. Ami, in any of his more recent studies from this locality.

The species of *Dalmanella*, which occurs so abundantly in the Arnheim of southwestern Ohio, is found also in the adjacent parts of Indiana. Southward, it is absent until the exposures at Newsom and Clifton, in western Tennessee are reached. There may have been a connection between southwestern Ohio and Tennessee by a path farther west than any now exposed. The origin of the *Dalmanella* found in the Arnheim of southwestern Ohio and the adjacent part of Indiana, however, may have been indigenous. In Franklin and Dearborn counties, in Indiana, *Dalmanella* occurs at various levels in the Arnheim, being quite abundant in the lower half. It occurs in the same area also at various levels in what is identified as the Mount Auburn. Near Brookville, it is very abundant in the Corryville, and it occurs in moderate numbers also in the more northern exposures of the Corryville in Ohio. Not all of the specimens of *Dalmanella* found in the Fairmount belong to *Dalmanella fairmountensis*. That species has a rather restricted geographical range. A derivative of *Dalmanella multisecta* is rather widely distributed at the *Strephomena plano-convexa* horizon, and it is from the Eden *Dalmanella multisecta* that the Arnheim species may have evolved. The vertical distribution of *Dalmanella* is limited to the lower part of the upper or Oregonia division of the Arnheim southeast of Butler and Hamilton counties, in Ohio, suggesting an entry into this area from the northwest, from Indiana.

Leptaena richmondensis is one of the most widely distributed species found in the Arnheim. It occurs almost over the entire area investigated, both north and south, wherever the Arnheim is known. It is a typical eastern Richmond species, and was certainly not derived from *Leptaena unicosta*, the western Richmond form. It is the latter species which has varied most from the primitive form. *Leptaena richmondensis* is least abundant in southeastern Indiana, and is entirely absent in southern Kentucky, along the Cumberland river. It is most abundant in southwestern Ohio and in central Kentucky. Probably the latter areas were once connected by Arnheim deposits which since have been eroded away, since there is a small area in western Lincoln and eastern Casey and Boyle counties, in Kentucky, from which *Leptaena* is absent. *Rhynchotrema dentata* is absent from the same area, in central Kentucky, and may have used the same hypothetical passage a moderate distance northward.

Rhynchotrema dentata is much more abundant southwards, in Kentucky, than northwards, and in Ohio and Indiana it is confined to the most southern exposures. Certainly, it would be difficult to imagine a northern origin for this species, as far as its entry into the Arnheim is concerned. Moreover, it occurs also at Goodletsville, Newsom, and Clifton, in western Tennessee. As in the case of *Dinorthis carleyi*, and *Leptaena richmondensis*, it had

its precursors already in the Trenton. The Trenton of New York, and New Jersey, for instance, contains a species of *Rhynchotrema* which is sufficiently like the Arnheim form to have served at least as an ancestral form. But this does not furnish a hint as to the direction from which the Arnheim fauna invaded the Cincinnatian areas.

Platystrophia ponderosa is another species which appears to have entered the Cincinnatian areas from the south. The species may have been of indigenous origin. It certainly is known in Kentucky as early as the Fairmount, if not the upper Eden, and was very abundant during the Corryville, and locally also during the Mount Auburn. In the Mount Auburn it is found in great numbers from the eastern half of Hamilton and Butler counties, in Ohio, southeastward to Maysville, in northern Kentucky, and thence southward toward Lincoln county. It is very rare at the Mount Auburn horizon in most parts of Indiana and in the adjacent parts of western Kentucky. During the lower or Sunset division of the Arnheim it occurs apparently only in the dark blue, argillaceous limestone between the southern part of Fleming county and the eastern part of Montgomery county. It occurs here in such small numbers that it is difficult to believe that it could have spread during the upper Arnheim over by far the larger part of the Cincinnatian areas from such a restricted source. During the earlier part of the upper Arnheim, before the advent of *Leptaena richmondensis*, *Rhynchotrema dentata*, and *Dinorthis carleyi*, it spread over southwestern Ohio, and along the eastern side of the Cincinnati geanticline as far south as Maysville, Kentucky.

Along the more southern exposures on the eastern side of the Cincinnati geanticline, from the eastern part of Montgomery county, in Kentucky, southward to Lincoln, and westward to Marion county, *Platystrophia ponderosa* occurs distinctly above the *Leptaena-Rhynchotrema* horizon. Between the more northern areas, in which *Platystrophia ponderosa* occurs beneath the *Leptaena richmondensis* horizon, and the more southern areas in which *Platystrophia ponderosa* occurs chiefly above the *Leptaena* horizon, there is an intermediate area, on both sides of the geanticline, in which *Platystrophia ponderosa* and *Leptaena richmondensis* occur together, in the same restricted zone, near the base of the upper or Oregonia division of the Arnheim. The anomalous association of these fossils at Collinsville, in the northern part of Butler county, has been mentioned already.

The occurrence of *Stromatocerium* in the Arnheim is limited to a relatively small area in central Kentucky, where, usually, it is quite rare excepting at a few localities. A single locality is known, in the southern part of Fleming county, where *Stroma-*

tocerium is present in the Mount Auburn bed. In southern Kentucky, along the Cumberland river, it occurred already during the upper Fairmount, often in great numbers. During the deposition of the Waynesville and later deposits of the Richmond, the species has a much wider geographical distribution.

In the table of Cincinnatian strata, the term Laughery is used to include the Waynesville and Liberty members of the Richmond, the Saluda being regarded as deposited during one of the more important diastrophic movements during this period. The typical exposures occur along the Laughery creek, in Ripley county, from the vicinity of Versailles to Osgood, Indiana.

On the accompanying charts, the letters designate the localities at which the writer found the species in question. The letters have the following signification:

D—Dinorthis carleyi.
R—Rhynchotrema dentata—arnheimensis.
L—Leptaena richmondensis—precursor.
P—Platystrophia ponderosa.
A—Dalmanella jugosa, var.
S—Stromatocerium huronense.

Platystrophia and Leptaena occur also 10 miles south of the southern margin of the area covered by these charts, in Adair county, Kentucky, as indicated by the direction of the small arrow on the charts. (See plates XX, XXI.)

PLATE XXII.

Fig. 1. Dalmanella jugosa. A, B, pedicel valves; C, D, brachial valves. E, F, G, interiors of brachial valves; H, interior of pedicel valve. Arnheim bed, south of Arnheim, Ohio.

Fig. 2. Heterospongia subramosa-knotti. Lateral view showing osculum surrounded by radiating channels. Arnheim bed, northwest of home of Col. J. B. Wathen, about a mile west of Lebanon, Ky.

Fig. 3. Platystrophia cypha-conradi. A, pedicel valve; B, C, anterior views. Arnheim bed, half a mile south of Smithville, in Bullitt County, Kentucky. These figures, in the order named, represent other views of the specimens illustrated by figures 14 A, 7 B, and 7 A, on Plate IV, in Volume XVI, of the Bulletin, Scientific Laboratories, Denison University, 1910.

Fig. 4. Platystrophia with outline of Pl. clarksvillensis, but the prominent median fold on the brachial valve has the two median plications much more conspicuously elevated than the lateral ones on the fold, as in Pl. cypha, to which it is closely related. Arnheim bed, south of Arnheim, Ohio.

Fig. 5. Platystrophia cypha. Anterior view of specimen represented by Figure 5, on Plate III, Bulletin, Denison University, 1910. Arnheim bed, three miles south of Maysville, Kentucky, in deep railroad cut.

Fig. 6. Platystrophia wallowayi. A, brachial valve; B, C, posterior views; D, anterior view; E, lateral view with the beaks directed downward. Arnheim bed, on Walloway Creek, two miles south of Rileys, in Marion County, Kentucky. Horizon, 15 feet above the lowest strata containing Leptaena richmondensis. A globose form with rather strong growth striae in the majority of specimens.

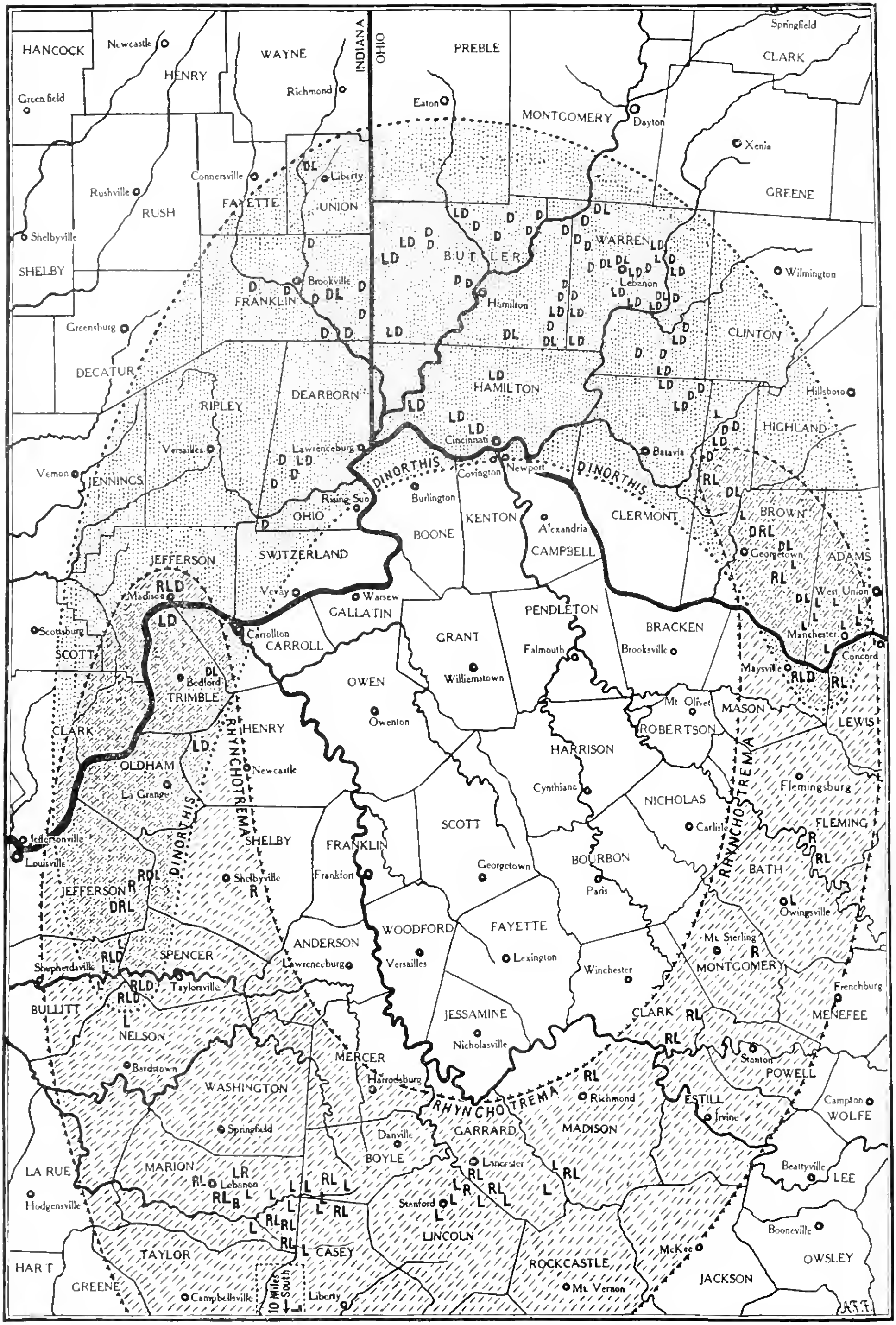
Fig. 7. Leptaena richmondensis-precursor. Brachial valve. Arnheim bed, one mile south of Pisgah, in the southeastern corner of Butler County, Ohio.

Fig. 8. Dinorthis carleyi. A, brachial valve; B, C, pedicel valves; D, interior of pedicel valve. Arnheim bed, Oregonia, Ohio. In Dinorthis retrorsa, of Wales, the median part of the brachial valve is figured as more angular in its elevation, with somewhat flattened lateral slopes.

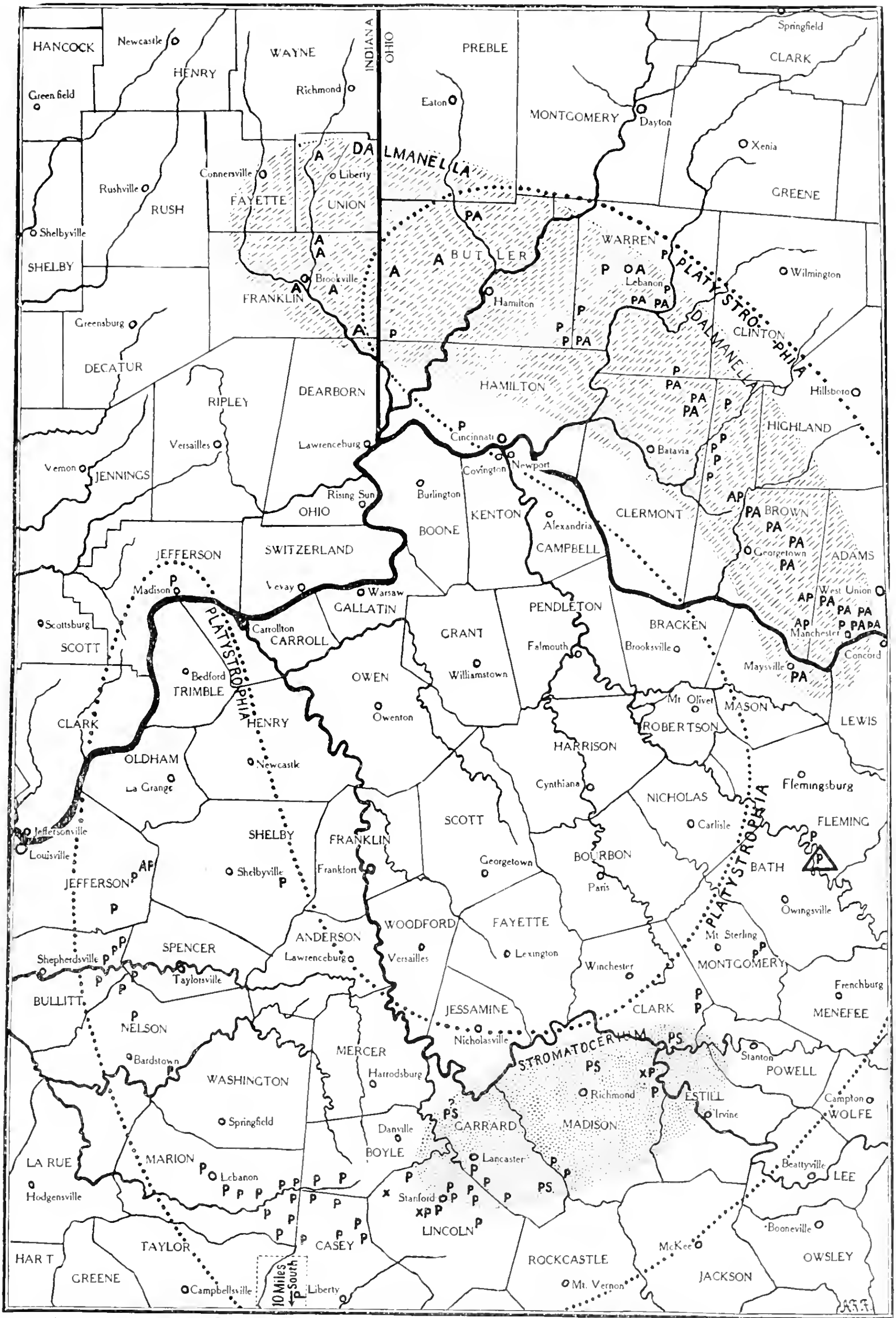
Fig. 9. Rhynchotrema dentata-arnheimensis. A, pedicel valve, from Arnheim, Ohio, from same specimen as Fig. 12, Plate IV, Volume XIV, Bulletin, Denison Univ., 1909. B, lateral view, of specimen from Mount Washington, Bullitt County, Kentucky. Arnheim bed.

Fig. 10. Strophemona concordensis. A, interior of brachial valve, three miles south of Maysville, Kentucky; B, interior of pedicel valve, more abruptly thickened along the anterior and lateral margin than in the great majority of specimens. Arnheim,bed, on Eddies Run, in Adams County, one mile east of Clermont County, along the pike from West Union to Decatur, Ohio.

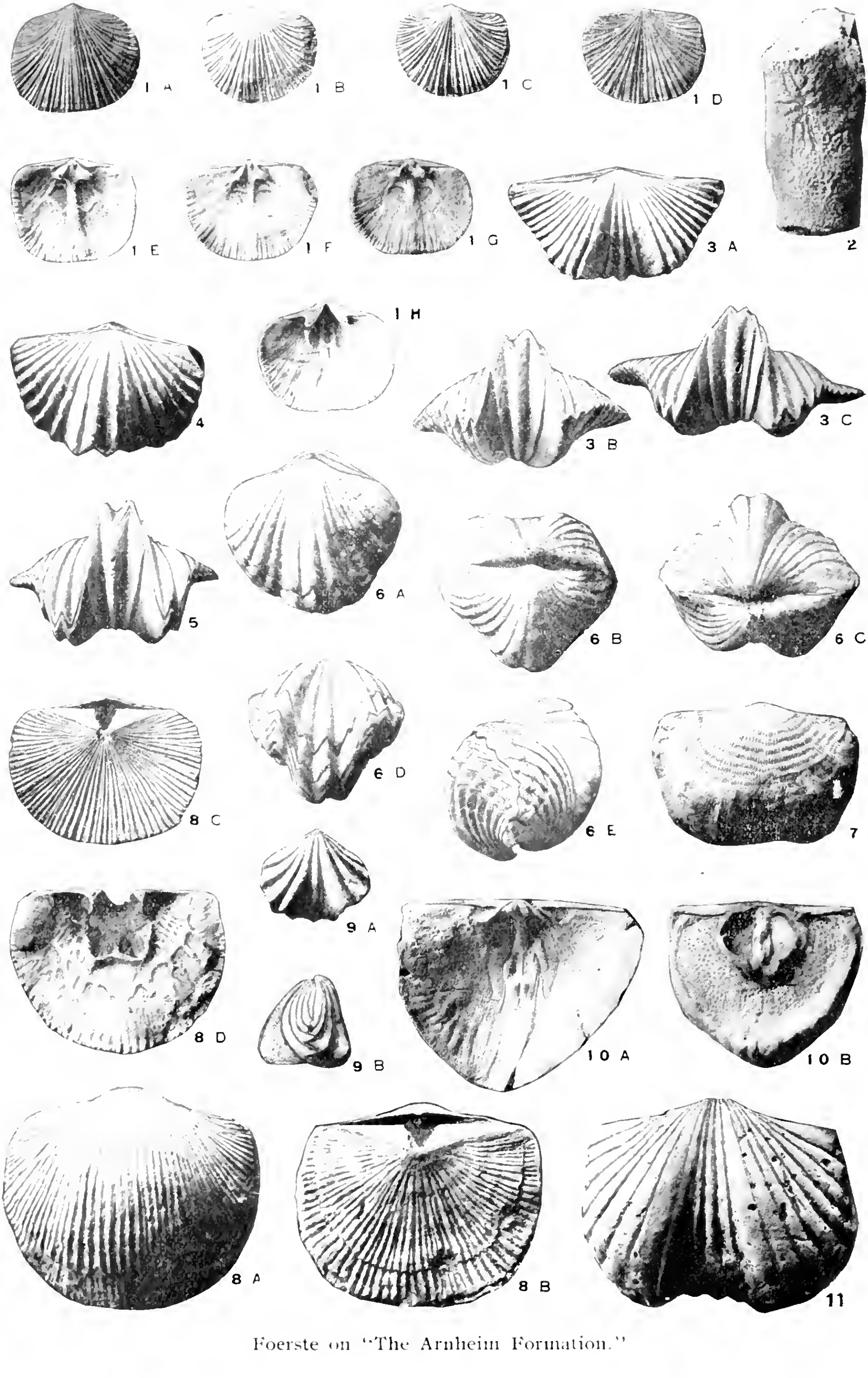
Fig. 11. Platystrophia ponderosa. Pedicel valve, rather strongly water worn, with holes bored by some other animal. Arnheim bed, south of Arnheim, Ohio.



DISTRIBUTION OF DINORTHIS CARLEYI, RHYNCHOTREMA DENTATA VAR., AND LEPTAENA RICHMONDENSIS VAR. IN THE ARNHEIM.



DISTRIBUTION OF PLATYSTROPHIA PONDEROSA, DALMANELLA JUGOSA, AND STROMATOCERIUM HURONENSE IN THE ARNHEIM. STROMATOCERIUM AT BASE OF MOUNT AUBURN. = Δ.



Foerste on "The Arnheim Formation."

NEW AND RARE PLANTS OF OHIO.

John H. Schaffner.

The following interesting plants have been added to the Ohio State Herbarium during the year 1911. Several species show a considerable extension of the range hitherto known:

Lycopodium clavatum L.
South Bloomingville, Hocking Co. R. F. Griggs.

Chenopodium vulvaria L. Fetid Goosefoot.
Columbia Station, Lorain Co. Sent by E. L. Fullmer; collected by Rev. E. H. Thompson.

Acnida concatenata Moq. Glomerate Water-hemp.
Columbus, Franklin Co. John H. Schaffner and Forest B. H. Brown.

Acnida tamariscina (Nutt.) Wood. Western Water-hemp.
Columbus, Franklin Co. John H. Schaffner and Forest B. H. Brown.

Magnolia tripetala L. Umbrella Magnolia.
On Turkey Creek, near Portsmouth, Scioto Co. Edmund Secrest.

Fragaria vesca alba (Ehr.) Rydb. White Strawberry.
Big Pine Creek, Hocking Co. R. F. Griggs.

Opuntia humifusa Raf. Western Prickly-pear.
Adams County, Ohio, opposite Vanceburg, Ky. Mr. and Mrs. Jesse E. Hyde.

Pyrola rotundifolia L. Roundleaf Wintergreen.
South Bloomingville, Hocking Co. John H. Schaffner.

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[1]Presented at the meeting of the Ohio Academy of Science, Columbus, December 1, 1911.

MEETINGS OF THE BIOLOGICAL CLUB.

Orton Hall, May 1, 1911.

The meeting was called to order by the President, Dr. Dachnowski, and the minutes of the previous meeting read and approved. The major paper of the evening was by Prof. J. H. Schaffner, who gave an interesting and instructive address on "The Classification of the Flowering Plants," presenting in general outline his own system of classification and arrangement. He emphasized the importance of working from a strictly evolutionary standpoint out of which a natural phyletic arrangement of the various large groups is bound to come. The actual working out of the phyletic groups is a most difficult problem but this should not in the least minimize its importance. Concerning plant organs and structures as a basis for classification, attention must constantly be given to their progressive development, segregation of parts, degeneration and their degree of specialization. The season made it possible for the speaker to illustrate his address with numerous flowers both cultivated and wild.

The next paper of the evening was by Mr. Wencil J. Kostir on "Evolutionary Thought in the Nineteenth Century"; The speaker gave a very concise yet thorough resume of the rise and development of modern evolutionary conceptions and presented the present day ideas relative to the important factors of the evolutionary process. This paper was the last of a series continued through the year on the History of Biology.

A short business meeting was held in which, on motion by Prof. Schaffner, the president was directed to appoint a nominating committee of three to select editors for the Ohio Naturalist for the ensuing year. No further business being presented the society adjourned.

Bertram W. Wells, Secretary.

Orton Hall, October 2, 1911.

The Biological Club met with President Dachnowski, presiding. C. L. Metcalf was appointed secretary pro tem. Messrs. Metcalf, King and Fulton were named as a committee to nominate a staff for the Ohio Naturalist. The reading of the minutes of the previous meeting was postponed. On motion the chair appointed Prof. Hine, Miss Detmers and Mr. Kostir a committee to nominate officers for the Club.

The program of the evening consisted of reports of summer work or observations. Prof Schaffner gave a short discussion of nutation habits of plants. Prof. Hine spoke of the Southern

Cotton Worm which is an occasional visitor far to the North of its usual range. The past year this insect occurred in extremely large numbers in the State as far north as Lake Erie. It is unable to winter even in the northern part of the cotton belt and is believed to fly northward in fall. The adults have been reported as puncturing the fruit of the peach.

Prof. Griggs reported finding *Lycopodium clavatum* near Rockbridge in Hocking Co. This plant has been reported only once before for Ohio, and the present report extends its known range about 100 miles.

Mr. Bentley Fulton spoke of a large colony of the Cicada-killer which he observed in the Hocking county region. Mr. Schadle also collected in Hocking county. Mr. Lyonel King spoke of the condition of forest near Lake of Bays, in northern Canada. Although distant from a railroad this region is well settled and very little virgin forest remains. Many of the trees are similar to those in Ohio. Mr. Kostir spent the summer in Hocking county, and spoke of the interesting topography of the region. Miss Sweatman devoted some time to the study of bird's nesting habits on Cedar Point and found that the natural materials at hand were largely used. Miss McAvoy told of finding the mocking bird in large numbers in Hamilton county, where they nest. Mr. Brown gave an interesting report of an experiment in landscape gardening. Prof. Dachnowski spent a part of the time in the Geological Survey and the latter part of the summer in Europe.

Orton Hall, November 6, 1911.

The Club met at the usual time. After reading and approval of the minutes the following officers were elected for the year.

President, W. M. Barrows; Vice President, T. M. Hills; Secretary, C. L. Metcalf.

The committee reported the following nominations for the staff of The Ohio Naturalist:

Editor-in-Chief, John H. Schaffner; Business Manager, James S. Hine.

ASSOCIATE EDITORS.

Zoology, W. M. Barrows; Botany, Robert F. Griggs; Geology, W. C. Morse; Physiography, T. M. Hills; Archeology, W. C. Mills; Ornithology, J. C. Hambleton.

ADVISORY BOARD.

Herbert Osborn, John H. Schaffner, Charles S. Prosser.

This report was accepted and the staff elected. Mr. Forest Brown, Mr. Charles K. Brain and Miss Blanche McAvoy were elected members of the club.

Vice-President Hills then took the chair and the society was favored with an address by the retiring President, Dr. Alfred Dachnowski. Prof. Dachnowski spoke on "Modern Tendencies in Science and their Relation to the Individual." He pointed out the restless activity of industry and the international organization of scientific work. The question was raised whether we are fitting men for institutions or institutions for men and whether we are proceeding in biological sciences and in politics, commercialism, etc., on the principle that all things are made for man, sovereign over inanimate things.

C. L. Metcalf, *Secretary.*

Date of Publication, January 19, 1912.

The Ohio Naturalist,

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SYMBIOTES DURYI, A NEW SPECIES OF ENDOMYCHIDAE.[1]

L. B. WALTON.

(Contributions from the Biological Laboratory, Kenyon College, No. 7.)

The genus Symbiotes of the family Endomychidae belonging to the Coleoptera has prior to the year 1908, been unrepresented by any described species from North America although Leconte and Horn (1883) erroneously referred *Rhymbus ulkei* Crotch, and *Rhymbus minor* Crotch, to this genus in their classification of the Coleoptera of North America.

Consequently it was with much interest that the writer in November, 1907, collected two specimens at Gambier, O., which through acquaintance with the European representatives of Symbiotes were immediately referred to that genus. This occurred only a few days prior to the annual Thanksgiving meeting of the Ohio Academy of Science at Oxford, presided over by the President, Mr. Charles Dury, of Cincinnati, an indefatigable collector of Coleoptera as well as a keen student of nature. It therefore seemed most appropriate that the name *duryi* should be conferred upon the species which had so opportunely presented itself, an idea which was carried into effect at the meeting, the specimens also being exhibited.

This was noted in the Proceedings of the Academy for 1907 (mailed about June 1, 1908). Blatchley, (1910), after communicating with the writer as to the systematic arrangement of the

[1]Read before the meeting of the Ohio Academy of Science, Columbus, December 1, 1911.

Endomychidae and the generic characters of the genus Symbiotes for his forthcoming paper on the Coleoptera of Indiana, gave a description of "*Symbiotes duryi* Walton MS" (p. 536) in that most excellent report. The collection and study of representatives of the genus however, had not at that time proceeded sufficiently so that the description is of value in differentiating this species from the several other species of Symbiotes occurring in North America.

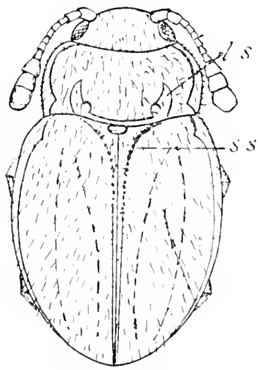

FIG. 1. *Symbiotes duryi* n. sp. (x25). ls = longitudinal sulcus. ss = subsutural stria.

The genus was founded by Redtenbacher in 1849 for the reception of *S. latus* the generic name being based on the supposition that the species was myrmekophilous. While at times *S. latus* as well as other European forms appear to have been found in association with ants, it is evidently not characteristic in general of the species and the actual habitat is rather one of association with the lower forms of fungi on the spores of which the individuals feed, as noted in another part of the present paper.

Only six species of Symbiotes have thus far been described, three from the European region, two from Japan, and one from South America.

The two representatives of the species which have been found were taken under a slightly decayed hardwood log near the south side of the "Hotel Hill" road bridge at Gambier, the log being partially covered with one of the lower forms of fungi, on the spores of which the Symbiotes feed. In accordance with other representatives of the genus, the species is exceedingly small, being less than 2 mm. in length. The drawings below (Fig. 2) indicate certain anatomical details. The description follows:

Symbiotes duryi n. sp.

Characters.—Form more or less broadly oval, moderately convex, scarcely pubescent, color dull testaceous; head scarcely punctuate, antennae with club moderate in size, 1. segment large, 2. segment narrow but of approximately the length of the 1. segment and equal to the 3. and 4. together, 3.–8. subequal in length but slightly increasing in diameter, 9. larger, triangular, 10. transverse, about three-fourths as long as the 9. 11. asymmetrically pointed. Prothorax twice as wide as long, strongly rounded anteriorly, broadest at middle, margins toothed, median region convex, base with a strong transverse sulcus from the lateral portions of which extend on each side triangular longitudinal sulci reaching anteriorly about half the length of the prothorax.

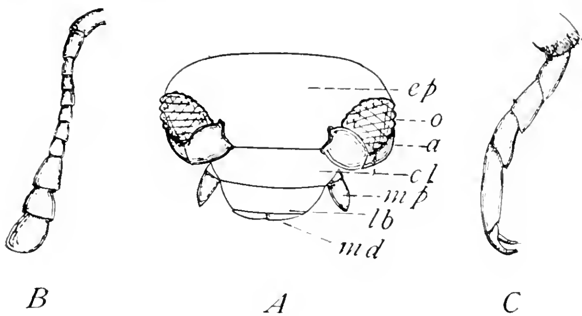

Fig. 2. *Symbiotes duryi.* A=head (x50). ep=epicranium. o=eye. a=second segment antennae. Cl=clypeus. mp=distal segment maxillary palpus. lb=labrum. md.=mandible.

B=antenna (x50). C=metathoracic tarsus (x100).

Elytra short, oval, decidedly broader than the prothorax, attaining their greatest width about one-fifth of their length from the base; punctures arranged in more or less confused rows; subsutural striae broadly curved at the scutellum and attaining the middle of the base of the elytra; composed of extremely large punctures which reach their maximum size near the scutellum.

Length 1.9 mm.

Distribution.—Gambier, Ohio, (U. S. A.).

The species is easily distinguished from its nearest ally *S. gibberosus* Lucas, of Europe, and from other undescribed North American species, through the comparatively much broader elytra and the extremely large punctures near the scutellum in the subsutural striae. Furthermore it is darker in color, and there is a difference in the arrangement of the ordinary elytral striae.

One of the specimens was partially dissected which afforded an opportunity of observing the contents of the digestive tract. This

was found to contain a mass of minute spores each somewhat oval in form and 10 mic. in length. The entire tract from the mid portion of the metathorax was filled with the spores, and by counting the number in a given area, an approximation of the total gave 13,500 for the number in the tract. Unfortunately the fungus with which the species was in association was not collected, so even the family to which it belonged cannot be noted with certainty.

It seems certain that Symbiotes will be found widely distributed in North America.

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THE MALLOWS OF OHIO.

MARY B. LINNELL.

MALVACEAE Mallow Family.

Mucilaginous, innocent herbs or shrubs with alternate, palmately-veined leaves and small deciduous stipules. Flowers hypogynous, regular, often large and showy, usually bisporangiate; calyx usually of 5 sepals more or less united, often with bracts at the base; corolla of 5 petals, convolute; andrecium of numerous stamens, the filaments united into a tube around the gynecium and also united with the base of the petals; ovulary with several cavities, styles united below, distinct above; stigmas usually as many as the cavities of the ovulary. Fruit a capsule with several cavities; the carpels falling away entire or else loculicidally dehiscent.

Synopsis of Genera.

I. Stamen-column anther-bearing at the tip; carpels 5–20 in a ring around a prominent central axis from which they separate when ripe.
 A. Carpels 1-seeded.
  1. Flowers bisporangiate.
   (1) Stigmas linear, on the inner face of the styles.
    a. Involucre of 1–3 bracts.
     (a) Carpels beakless; petals obcordate. *Malva.*
     (b) Carpels beaked; petals truncate. *Callirrhoe.*
    b. Involucre of 6–9 bracts. *Althaea.*
   (2) Stigmas terminal, capitate. *Sida.*
  2. Flowers monosporangiate, diecious. *Napaea.*
 B. Carpels 2—several seeded. *Abutilon.*
II. Stamen-column naked at the 5-toothed tip; carpels forming a loculicidal capsule.
 A. Involucre of many bracts. *Hibiscus.*

Key.

1. Flowers without an involucre. 2.
1. Flowers with involucre below the calyx. 4.
2. Leaves not lobed; flowers bisporangiate. 3.
2. Leaves deeply lobed; flowers diecious. *Napaea.*
3. Leaves broadly cordate, abruptly acuminate. *Abutilon.*
3. Leaves ovate-lanceolate, acute. *Sida.*
4. Stamen-column anther-bearing below the entire or 5-toothed summit; involucre of numerous linear bracts. *Hibiscus.*
4. Stamen-column anther-bearing at the summit. 5.
5. Involucre of 6–9 bracts united at the base. *Althaea.*
5. Involucre usually of 3 free bracts. 6.
6. Carpels beakless; petals obcordate; leaves divided or only slightly lobed. *Malva.*
6. Carpels beaked; petals truncate; leaves parted or divided. *Callirrhoe.*

Malva L.

Pubescent or glabrate herbs with dentate, lobed, or dissected leaves, and axillary or terminal, solitary or clustered flowers. Carpels beakless, arranged in a circle, indehiscent; cavities of ovulary several or numerous, 1-ovuled; seed ascending.

1. Leaves with shallow rounded lobes; flowers clustered in the axils. 2.
1. Leaves deeply 5–7 lobed or pinnatified; flowers only in the upper axils. 4.
2. Stems procumbent; root perennial; petals 1–2 times the length of the calyx. *M. rotundifolia.*
2. Stems erect, annual or biennial. 3.
3. Leaf margins not much crisped; biennial; petals 2–4 times the length of the calyx. *M. sylvestris.*
3. Leaf margins very much crisped; annual; petals 1-2 times the length of the calyx. *M. crispa.*
4. Stem leaves 5-parted; the divisions pinnatified into linear lobes, carpels downy, cleft, the divisions broad. *M. moschata.*
4. Stem leaves deeply 5–lobed, carpels smooth. *M. alcea.*

1. Malva sylvestris L. High Mallow.

Biennial, erect or ascending, pubescent with spreading hairs; leaves obicular and reniform, truncate or cordate at the base; flowers reddish purple, carpels about 10. In waste places and along roadsides. Auglaize, Cuyahoga Co.

2. Malva rotundifolia L. Roundleaf Mallow.

Annual or biennial, procumbent and spreading; leaves orbicular reniform; blades 2 inches wide, petioles about 6 inches long; flowers clustered in the axils, petals pinkish white with 3 reddish nerves, carpels about 15. In fields and waste places. General.

3. Malva crispa L. Curled Mallow.

Annual, glabrous, or nearly so; leaves nearly orbicular with shallow, angular, crenate lobes with wrinked crisped margins; blades 5 inches wide; petioles 5 inches long; flowers ½ inch long, ½ inch in diameter. In waste places. No specimens.

4. Malva alcea L. European Mallow.

Perennial, procumbent, pubescent. Stem leaves only once 5-7 parted or cleft, the lobes dentate or incised, blades 3 inches long, 4½ inches wide, petiols 1½ to 4½ inches long; flowers 1¾ inches in diameter. In waste places. Escaped in Cuyahoga Co.

5. Malva moschata L. Musk Mallow.

Perennial, pubescent with long hairs. Basal leaves orbicular with broad, rounded, dentate lobes; stem leaves deeply divided into linear or crenate, pinnatified or cleft segments; stem leaf blades 2 inches long, 2 inches wide, petiols 1½ inches long. Flowers 1½ to 2 inches in diameter. In waste places. Northern part of the State as far south as Muskingum Co.

CALLIRRHOE Nutt.

Herbs with lobed or divided leaves and showy flowers. Bracts of the involucre 1-3, separate, or none. Petals cuneate, often toothed or fimbricate. Carpels beaked, 10-20, forming an ovulary with equal number of cavities. Cavities 1-ovuled and 1-seeded.

1. **Callirrhoe involucrata** (T. & G.) A. Gray. Purple Poppy-mallow.

Perennial, procumbent, ascending herbs, 1-2 feet long, pubescent with long hispid hairs; taproot fleshy sometimes reaching to depth of 10 or more feet. Leaves cordate-orbicular, the lobes dentate or incised, blades 3 inches wide, $2\frac{1}{2}$ inches long; petioles 3-5 inches long. Flowers bright red purple, $1\frac{1}{2}$ inches wide. A waif in Franklin Co.

ALTHAEA L.

Pubescent herbs with lobed or divided leaves and solitary or racemose flowers. Involucre of 6-9 united bracts; carpels and cavities of the ovulary numerous, separating at maturity into 1-seeded fruits.

1. Leaves more or less 3-lobed, very velvety, the lobes acute. *A. officinalis.*
1. Leaves with 5-7 rounded lobes, with hairy pubescence. *A. rosea.*

1. **Althaea officinalis** L. Marsh-mallow.

Perennial plants; leaves ovate, dentate, and generally 3-lobed, blades $2\frac{1}{2}$ inches broad and $2\frac{3}{4}$ inches long. Waif in Scioto Co.

2. **Althaea rosea** Cav. Hollyhock.

Perennial plants 10 feet or less tall; leaves cordate, dentate, blades 3-6 inches broad, $3\frac{3}{4}$ to $4\frac{1}{2}$ inches long, petioles 3-7 inches long; flowers 4 inches in diameter. Lucas, Erie, Madison, Montgomery, Brown, and Scioto Co.

SIDA L.

Herbs with serrate, crenate, or lobed leaves and bisporangiate flowers. Involucre none, cavities of the ovulary 1-ovuled, indehiscent, or two-valved at apex.

1. Leaves not lobed, ovate, or oblong-lanceolate. *S. spinosa.*
1. Leaves palmately lobed or palmately veined, glabrous or nearly so, tall. *S. hermaphrodita.*

1. **Sida spinosa** L. Prickly Sida.

Annual ascending, finely pubescent; leaves ovate, blades 1 inch wide, 2 inches long, petiole 1 inch long. Rather general.

2. **Sida hermaphrodita** (L.) Rusby. Tall Sida.

Perennial; leaves ovate, orbicular, deeply 3-7 lobed, the lobes lanceolate or ovate, incised, dentate, acute or acuminate, blades 4 inches wide, $5\frac{1}{2}$ inches long; flowers white and numerous. No specimens.

NAPAEA L.

Erect, perennial herbs, with palmately-lobed leaves and small, white diecious flowers in corymbose panicles; involucre none, carpels 8-10, separating at maturity into 1-seeded fruits.

Napaea dioica L. Glade-mallow.

Stems and leaves glabrous, or nearly so, leaves 5–9 lobed, lobes incisely cut and acute, leaf blades 8–20 inches wide, 4–10 inches long; flowers white, diecious. Defiance, Clark, Madison, Franklin, Fairfield and Highland Co.

ABUTILON Gaertn.

Ours annual herbs, soft pubescent with cordate leaves; involucre none; carpels usually 10–15 united, each cavity 3–9 ovuled, dehiscent at maturity.

Abutilon abutilon (L.) Rusby. Velvet-leaf.

Annual, stout, 6 feet high, densely velvety pubescent; leaves long petioled, cordate, orbicular, dentate or nearly entire; blades 3–9 inches wide, 3–9 inches long. General and abundant.

HIBISCUS L.

Herbs or shrubs with dentate or lobed leaves and showy campanulate flowers. Bracts of the involucre numerous and narrow; gynecium of 5 united carpels, ovulary 5-locular with 3 or more ovules in each cavity, capsule 5-valved.

1. Leaves lobed. 2.
1. Leaves deeply divided. *H. trionum.*
2. Leaves ovate, not prominently lobed, obtuse at the base; stem and lower surface of leaves pubescent. *H. moscheutos.*
2. Leaves commonly halberd-form; three-lobed, truncate at the base; stem and leaves glabrous. *H. militaris.*

Hibiscus moscheutos L. Swamp Rose-mallow.

Erect, leaves ovate or ovate-lanceolate, cordate or obtuse at the base, acute or acuminate at the apex, sometimes lobed at the middle, palmately veined, dentate or crenate, leaf blades $3\frac{1}{2}$–4 inches wide, 4–$5\frac{1}{2}$ inches long, petiole 2–$2\frac{1}{2}$ inches long; flowers 6 inches in diameter. Ashtabula, Cuyahoga, Erie, Wayne, Licking, and Perry Co.

Hibiscus militaris Cav. Halberd-leaf Rose-mallow.

Erect, nearly glabrous, leaves ovate in outline, acute or acuminate, cordate or truncate at the base, margins dentate-crenate, the lower or all of them hastately lobed, leaf blades $3\frac{1}{2}$ inches wide at the base, $3\frac{1}{2}$–4 inches long, petioles $2\frac{1}{2}$–3 inches long; flowers $2\frac{1}{2}$ inches in diameter; reddish pink in color. Lucas, Defiance, Paulding, Auglaize, Shelby, and Franklin Co.

Hibiscus trionum L. Bladder Ketmia.

Annual, pubescent; leaves ovate or orbicular in outline, 3–7 lobed or divided, lobes obtuse, dentate-crenate or cleft, leaf blades $1\frac{1}{2}$ inches wide, 1–2 inches long; fruiting calyx inflated, membranous, 5-winged. General.

ANOTHER OHIO GROWN RUBBER.[1]

CHAS. P. FOX.

Of the many kinds of crude rubber, the botanical family, Apocynaceae, produces its share of good grades. Mangabeira (genus Hancornia in Brazil), Benguela root rubber (Landolphia) and Funtunia, both Africans, are notable examples.

The Apocynaceae are trees, shrubs, and herbs, with a milky acrid juice, numbering some 1000 species, grouped into 130 genera, inhabiting sub-tropical areas. This family of plants produces a varied line of economic products, such as edible fruits, dyes, drugs, fibres, ornamental plants and caoutchouc. The Madagascar Ordeal Plant, whose seed contains the most powerful poison known, and Eden's Forbidden Fruit, register here.

Several members of the type genus Apocynum, of this family, are common to the United States, the so-called Indian Hemp, Apocynum cannabinum and A. androsaemifolium. During the past summer, I have examined the latex of the latter species for quantity and quality of its rubber. The results of this investigation show that the latex of this plant gives a small quantity of good grade rubber.

The *latex* is white, viscous, neutral or slightly acid, and has the strong acrid odor peculiar to this plant. The latex reacts with the usual coagulating reagents, in the following manner:

Acids do not coagulate; latex becomes thin.

Alkalies do not coagulate; restore the viscosity; change the color from white to brownish yellow.

Boiling coagulates slightly and slowly.

Acetone in proportion of 1/10 volume, coagulates immediately and completely; liquid is colored chocolate red.

Formaldehyde coagulates readily, but is much slower than acetone.

Phenol coagulates the latex, but gives a soft product.

Salt Solution coagulates slowly, giving a finely divided precipitate, hard to coalesce. *Boiling* the saline solution gives a soft product; not successful. Of the above methods, the use of acetone or alcohol, and formalin, are the only ones recommended. Of these two, acetone is preferred.

The latex of Apocynum differs from that of Asclepias in that it coagulates spontaneously, even if it is kept in closed containers. The spontaneously coagulated latex gives:

Liquid portion	67.58%
Cheese (wet)	32.42%

1. Presented at the Twenty-first Annual Meeting of the Ohio Acad. of Sci., Dec. 1, 1911, Columbus.

The liquid is white, slightly acid and acrid odor. This liquid failed to coagulate after addition of more acid. Slight excess of alkali increased its viscosity, changed its color from white to brownish yellow, but did not coagulate or precipitate it. Boiling had no effect. Excess of acetone gave a finely divided precipitate the particles of which were not cohesive. Evaporation of the mixture, after washing with water and treatment with boiling acetone, gave a small quantity of black, soft rubber, destitute of strength. The *cheese* was composed of:

Water	33.46%
Rubber	3.99%
Resin	62.95%

Working up this *cheese* of the plant in the usual manner with solvents, straining through gauze to remove dirt, evaporating, with low heat, the excess of solvent adding an excess of precipitant, washing the precipitant and dissipating the precipitating agent, gave a good grade rubber.

The rubber obtained in this manner is black, firm, not tacky, odorless and strong. In quality it is much better than the product obtained from its neighbor, Milkweed. The qualities of this rubber confirm the old adage "that blood is thicker than water," and proves a more apt one, "that Apocynaceous rubbers are good rubbers."

Milkweed latex, however, is richer in rubber than that of Indian Hemp. The proportion of rubber in the entire plant remains on the same ratio as the amount of latex remains equal, and in both cases is entirely too small to be profitable. Of the total rubber present in the latex, 96% of it is won in the cheese formed by the natural coagulation of the latex. Ninety-six per cent of the total rubber found, ranks as Grade A, and four per cent grades as C.

The resin is mahogany red, transparent, medium hard, slight characteristic odor and tasteless.

During this investigation we have found that the soil conditions under which the plant was grown, exerts an influence upon the amount of rubber in the latex. Plants grown upon dry, sandy soil of West Akron, gave a latex containing 2.27% rubber and 20.69% resin. The latex of plants grown upon the wet swamps of South Akron, contained 1.12% rubber and 15.04% resin. Rubber from dry grown plants is of better quality than that of wet grown plants.

Natural latex from dry land Apocynum contains:

Water	72.29%
Solids	26.21%
Ash	1.59%

This rubber content in fresh latex is 2.36%.

The above figures refer to latex taken from plants near the end of the growing season.

Apocynum also gives *apocynin*, a drug having a similar action to digitalis and, according to Biddle, being an efficacious remedy in dropsy. The bark of this plant gives a strong, tough fibre, at one time much esteemed by the American Indians for bowstrings and fishing nets.

Akron, Ohio.

PLANTS NOT RECORDED IN THE OHIO LIST FROM CUYAHOGA AND LAKE COUNTIES.

Edo Claassen.

1. Crucibulum vulgare, Tul. On dead willow-bark. Cuyahoga and Lake; on manure: Cuyahoga; on plant-remnants: Cuyahoga.

2. Cyathus stercoreus, (Schw.) De Ton. On manure: Cuyahoga.

3. Cyathus striatus, (Huds.) Hoffm. On the ground and on decayed bark between moss: Cuyahoga.

4. Cyathus vernicosus, (Bull.) DC. On clayey ground; Cuyahoga.

5. Erysiphe cichoracearum, DC. Cuyahoga. On Aster macrophyllus, L.; collected September 10. Helianthus tuberosus, L.; collected September 20 and October 10. Phlox paniculala, L.; collected October 10 and 16.

6. Microsphaera alni, (DC.) Winter. Cuyahoga. On Ligustrum vulgare, L. (cult.), collected October 2 and 10 and 20.

1. Aristida oligantha, Michx.; Cuyahoga.

2. Eragrostis pectinacea, (Michx.) Steud.; Cuyahoga.

Specimens of the above plants are contained in the writer's herbarium.

A PRELIMINARY LIST OF THE MYXOMYCETES OF CEDAR POINT.[1]

E. L. Fullmer.

Eight species were represented by specimens in the herbarium at Cedar Point at the beginning of the present season, as follows:

Arcyria nutans (Bull.) Grev.
Dictydium cancellatum (Batsch) Macbr.
Diderma crustaceum Peck.
Lachnobolus globosus (Schw.) Rost.
Lindbladia effusa (Ehr.) Rost.
Mucilago spongiosa (Leyss.) Morg.
Physarella oblonga (B. & C.) Morg.
Trichia inconspicua Rost.

Specimens representing the following fourteen species were added to the herbarium during the summer of 1911.

Arcyria cinerea (Bull.) Pers.
Arcyria denudata (L.) Sheld.
Badhamia orbiculata Rex.
Didymium squamulosum (A. & S.) Fr.
Didymium crustaceum Fr.
Hemitrichia intorta List.
Lycogala epidendrum (Buxb) Fr.
Lycogala flavo-fuscum (Ehr.) Rost.
Ophiotheca wrightii B. & C.
Stemonitis fenestrata Rex.
Stemonitis maxima Schw.
Stemonitis smithii Macbr.
Tilmadoche alba (Bull.) Macbr.
Tubifera ferruginosa (Batsch) Macbr.

1. Presented at the meeting of the Ohio Acad. of Sci., Dec. 1, 1911.

ADDITIONS MADE TO THE CEDAR POINT FLORA DURING THE SUMMER OF 1911.[1]

E. L. Fullmer.

Additions made to the Cedar Point Flora during the summer of 1911:

Lithospermum arvense L.

At the edge of a recent lagoon near the Breakwater, and growing in the Juncus association, June 28, 1910. O. E. Jennings. Seed very likely reached this place by means of water transportation.

Cycloloma atriplicifolium (Spreng.) Coult.

On sandy banks of newly formed lagoons near the Breakwater. O. E. Jennings, June 26, 1911. Prof. Moseley had known of the occurrence of this species here in previous years but evidently had not reported it. Probably introduced by water-transportation frojm the upper Great Lake region.

Archangelica atropurpurea (L.) Hoffm.

In marshy vegetation surrounding a lagoon near the Breakwater. O. E. Jennings, June 26, 1911.

Dipsacus sylvestris Huds.

In wave-washed debris along the shore of the Bay about two miles south of the Laboratory. O. E. Jennings, July 13, 1911.

Triadenum virginicum (L.) Raf.

Around the shore of the Lily Pond, northwest of the Breakers Hotel. O. E. Jennings, July 18, 1911. The sudden appearance of this species around the pond in a narrow strip of vegetation, which had been thoroughly surveyed the year before, suggests that birds must have brought in the seeds.

Miss Blanche McAvoy did some work upon the Grasses and Sedges of Cedar Point and as a result of her work the following three species are added to the list:

Panicum ovale Ell. June 23, 1911.
Panicum villosissimum Nash. June 23, 1911.
Scirpus occidentalis (Wats.) Chase. June 27, 1911.

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1. Presented at the meeting of the Ohio Acad. of Sci., Dec. 1, 1911.

THE DIURNAL NODDING OF THE WILD CARROT AND OTHER PLANTS.

John H. Schaffner.

Many plants exhibit periodical movements during the twenty-four hours of a day. Among the more interesting of such movements is the daily nodding in the evening, shown by a number of species common along the roadside.

During the past summer the writer obtained considerable pleasure in making observations on some of the common plants of Columbus. One of the most striking in this respect is the wild carrot (Daucus carota L.) In thrifty plants there are usually a number of branches which all begin to nod at an early age and continue the habit until the plant is in full bloom. The best time to study this peculiar phenomenon is from the middle of June to the middle of July. The long peduncles, bearing the young umbels nod before the sun goes down, the curving being prominent by six o'clock. The various branches nod in a radial manner outward from the central axis of the plant. The length of time taken to develop the curve was not ascertained but it was observed that the peduncles are erect in the morning and remain so during the day. Late in the afternoon, the curving begins and continues until in some cases the peduncle describes nearly a circle. The nodding is most striking just before the blooming period in plants with numerous long peduncles. At this period the umbel frequently moves through an angle of over 270°. Frequently the upper face of the umbel touches the side of the peduncle. The diameter of the curve in a medium sized peduncle is about two inches. The curved peduncle is quite rigid and should show an interesting cellular condition if properly studied. The diurnal nodding of the peduncle stops at the time of anthesis, although there are subsequent interesting movements in the rays of the umbel itself at a later period.

The common Dogfennel (Anthemis cotula L.) also has the diurnal nodding habit. Its numerous lateral branches bearing heads of flowers nod in the evening and at night and become erect again early in the morning. The nodding takes place in the same radial manner as in the wild carrot.

In Lactuca hirsuta Muhl., before and during anthesis a decided drooping or nodding of the large flower cluster occurs, the main axis bending about six inches from the tip. The stems were found erect in the morning. Euphorbia nutans Lag., as its name indicates, also has a nodding of the tips of the stems each evening and a return to the erect position in the morning.

One may well ask as to the purpose of the nodding habit so prominently developed in the wild carrot. Is the cause of the

movement the lowering of the temperature, the decrease of light, or the fatigue of the protoplasm? These problems are for the plant physiologist. But anyone will find the habits interesting in themselves. They show that there is a real plant behavior as well as an animal behavior and by taking an evening ramble before and after sunset the fact will become evident that many plants change their positions with the coming of the night even as do most of the animals.

PLANTS RECOGNIZED ON A DUMPING GROUND AT THE FOOT OF NINTH STREET, CLEVELAND, OHIO.

Edo Claassen.

It was during the month of June that I visited this locality. Being quite surprised by the great number of different plants I saw growing there, I resolved to make a close inspection of a part (about 40 acres) of this tract of land in the course of several weeks. The result is contained in the following list, which is arranged in conformity with "Britton and Brown's Flora."

Mosses.

Funaria hygrometrica, L.
Bryum argenteum, L.
Leptodon piriforme, Hampe.

Gramineae, Juss.

Agrostis alba, L.
Avena sativa, L.
Cenchrus tribuloides, L.
Eragrostis eragrostis, (L.) Karst.
Eragrostis pilosa, (L.) Beauv.
Festuca elatior, L.
Hordeum vulgare, L.
Ixophorus glaucus, (L.), Nash.
Panicum capillare, L.
Panicum crus galli, L.
Panicum proliferum, Lam.
Panicum virgatum, L.
Phleum pratense, L.
Poa annua, L.
Poa compressa, (L.) Beauv.
Poa pratensis, L.
Syntherisma sanguinale, (L.) Nash.
Triticum vulgare, L.
Zea Mays, L.

Juncaceae, Vent.

Juncus bufonius, L.

Salicaceae, Lindl.

Populus alba, L.
Salix nigra, Marsh.

Polygonaceae, Lindl.

Polygonum aviculare, L.
Polygonum cilinode, Michx.
Polygonum erectum, L.
Polygonum lapathifolium, L.
Polygonum persicaria, L.
Rumex acetosella, L.
Rumex altissimus, L.
Rumex crispus, L.
Rumex obtusifolius, L.

Chenopodiaceae, Dumort.

Atriplex hastata, L.
Chenopodium album, L.
Chenopodium ambrosioides, L.
Kochia scoparia, (L.) Roth.
Salsola Tragus, L.

Amaranthaceae, J. St. Hil.

Amaranthus graecizans, L.
Amaranthus retroflexus, L.

Aizoaceae, A. Br.

Mollugo verticillata, L.

Cruciferae, B. Juss.

Lepidium Virginianum, L.
Sisymbrium altissimum, L.
Sisymbrium officinale, (L.) Scop.

Rosaceae, B. Juss.

Potentilla Monspeliensis, L.

Drupaceae, DC.

Amygdalus persica, L.

Papilionaceae, L.
Medicago sativa, L.
Melilotus alba, Desv.
Melilotus officinalis, (L.) Lam.
Trifolium pratense, L.
Trifolium repens, L.

Oxalidaceae, Lindl.
Oxalis stricta, L.

Euphorbiaceae, J. St. Hil.
Euphorbia maculata, L.

Malvaceae, Neck.
Malva rotundifolia, L.

Onagraceae, Dumort.
Onagra biennis, (L.) Scop.

Umbelliferae, B. Juss.
Anethum graveolens, L.
Daucus carota, L.

Convolvulaceae, Vent.
Convolvulus sepium, L.

Verbenaceae, J. St. Hil.
Verbena hastata, L.

Labiatae, B. Juss.
Nepeta cataria, L.

Solanaceae, Pers.
Datura Stramonium, L.
Lycopersicum Lycopersicum, (L.) Karst.
Physalis pruinosa, L.
Solanum carolinense, L.
Solanum nigrum, L.
Solanum tuberosum, L.

Scrophulariaceae, Lindl.
Verbascum thapsus, L.

Plantaginaceae, Lindl.
Plantago major, L.

Cichoriaceae, Reichenb.
Lactuca canadensis, L.
Lactuca Scariola, L.

Ambrosiaceae, Reichenb.
Ambrosia artemisiaefolia, L.
Xanthium canadense, Mill.

Compositae, Adans.
Achillea millefolium, L.
Anthemis cotula, L.
Arctium Lappa, L.
Artemisia biennis, L.
Aster paniculatus, Lam.
Bidens cernua, L.
Bidens frondosa, L.
Carduus arvensis, (L.) Robs.
Carduus lanceolatus, L.
Erigeron annuus, (L.) Pers.
Erigeron canadensis, L.
Erigeron ramosus, (Walt.) B. S. P.
Euthamia graminifolia, (L.) Nutt.
Galinsoga parviflora, (Cav.) DC.
Helianthus annuus, L.
Solidago canadensis, L.

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LIFE-HISTORIES OF SYRPHIDAE III.

C. L. METCALF.

Syrphus Americanus Wiedemann.

This is one of the most common species in the state, the adults especially abundant about all kinds of blossoms in July and August, as well as very early in the spring. The larvæ are active and greedy and found preying on a number of different aphids in large numbers. It would seem to be one of the most important species of Syrphidæ in the state from an economic standpoint

Egg.

Elongated-ovate in outline, sub-cylindrical, narrower and truncate at micropylar end, nicely rounded off at the opposite end, broadest in front of the middle (Fig. 42); somewhat flattened to the surface to which it is attached, slightly humped or rounded up above (Fig. 41). Length about 0.9 mm., diameter at middle about 0.3 mm. Color chalk white, hence conspicuous on the darker surface of leaf or twig on which it is usually deposited.

The entire exposed surface of the egg is beautifully sculptured except a small region around the dark micropyle. This sculpturing consists of microscopic projections of the surface arranged in lines running longitudinally-obliquely around the egg. Each projection consists of a long, slender, irregular body (seven or eight times as long as broad) sometimes bent, with about twelve to twenty slender arms reaching out in all directions from it. The space between these bodies is roughly a half wider than the body itself. Into these spaces the arms project, most of them meeting similar projections from the same or another body, many branching so as to form a delicate network of slender white arms between the larger bodies. Fig. 43 is a fair representation of a small part of the surface of the egg-shell, highly magnified. The projections are chalk white, the depressions between them shaded, appearing

grayish or yellowish. The bodies are of such a size that one may count about 25 the length of the egg and about 50 around it. transversely.

Eggs of this species were deposited on braches and leaves of apple at Columbus, the spring of 1911, from about May 8 to May 15. As this was a late season, however, oviposition for the first spring generation may usually be expected somewhat earlier.

Two females taken on May 8, about blossoming apple oviposited late the same day and on the following day. 35 to 40 eggs were deposited by each female. Oviposition, although rapid at times, extended over parts of two days. Apparently at times the hind legs assisted in deposition of the eggs. They are deposited singly sometimes not over a minute apart but usually some little distance away.

At Cedar Point, Ohio, eggs were found on Phragmites from June 20 to July 10. At Lakeville, Ohio, on Dock (*Rumex* sp.) June 15–20.

Duration in the egg stage indoors at a temperature of about 90° Fahr. was from 55 to 60 hours.

On apple these eggs were laid on the smaller, tenderer shoots and on young leaves, the parts most affected by plant lice. On dock they are placed on leaves, on buds, in leaf-axils, or on the stems. On Phragmites the eggs were found on both the under and the upper side of the leaves. On Black Willow along the smaller outer twigs.

The eggs are deposited on the surface of the twigs and leaves. They lie flat and are glued rather firmly so that sometimes they break before being dislodged. Flies imprisoned in glass jars oviposit mostly on the surface toward the light although twigs or leaves enclosed receive some eggs.

The eggs of Syrphidæ so far as known to me have a rather characteristic appearance. The shape and white color may serve to distinguish them from eggs of many other insects. I know of no naked eye characters that are specific. The size of the egg and number and characteristics of the microscopic,sculptured bodies, as described above, may serve to distinguish those of *Syrphus americanus.*

I have noted no methods of natural protection unless it be the sheltered positions in which they are sometimes placed; nor have I discovered any egg parasites.

Larva.

There is a considerable change in appearance and characteristics during the growth of the larva. Just after hatching the characters are as follows (Fig. 45): Length 1.2 mm., width 0.2 to 0.3 mm. Shape sub-cylindrical, smaller anteriorly, not enlarged medially. Color, light yellow or with a greenish tinge. Body

surface wrinkled, sides irregular. Segmental spines on second thoracic (4th) to penultimate (11th) segments, inclusive, and the dorso-lateral ones on the prothoracic (3rd) very long, slender, black, giving the young larva a very hairy appearance, so far as I know characteristic of this species. The posterior breathing appendages are short, slightly divergent (Fig. 45, *a*). General body surface bare. The dorsal blood-vessel shows faintly in the posterior half of the body.

During subsequent growth these slender segmental hairs are replaced by shorter, stouter, more spine-like bristles; the posterior breathing appendages are slightly elevated becoming united on the median line; and minute black spines appear all over the dorsal surface of the body.

Mature larva: Length 11 mm., width 2.5 mm., height 2 mm. (Fig. 46). Eruciform, legless. The segments are not all definitely marked. On the basis of the segmental spines ten segments can be clearly made out posterior to, and including, the one bearing the anterior spiracles (Fig. 46, *b*). These spiracles may be considered prothoracic, hence we have ten segments exclusive of the head. The head segments are small retractile somewhat indefinite with some appearance of being two in number. For convenience of reference, therefore, the total number has been considered as 12, making the prothoracic, number 3.

Compared with many other aphidaphagous larvæ those of this species are noticeably slenderer, in outline with more nearly parallel sides. Segments 6 to 11 are of nearly equal width; the last one is narrower and much depressed; while anterior to segment 6 the body tapers evenly to the mouth-parts when extended, or rounds off at segment 4 when at rest, with the head segments retracted.

The body wall is prominently wrinkled, transversely, and with the usual two longitudinal carinæ at each side. From above as in Figure 46, the ventral of these carinæ is hidden by the dorsal one.

General color yellowish, or salmon-brown, marked with black and white or yellowish white. The whitish markings consist of a transverse rectangular bar on each segment from 6 to 11 and a narrow line along each side of the larva in the dorsal lateral carinæ. Interrupted by the transverse white bars in the median line is the heart line or dorsal blood-vessel, consisting of six, elongate, wedge-shaped black marks broadly margined with brown. Laterad of the brown are other prominent black blotches extending obliquely outward and back to the whitish lateral carinæ. The anterior end for two or three segments is unmarked with the black or brown and is light greenish yellow in color.

Examined more in detail the color markings may be described as follows: The brown color is resident in bodies of globular fatty material which is visible through the thin and transparent, though tough, body wall. It begins in the head segments where there is

a small rounded mass; runs in a narrow median line back to segment 5; forks around the first division of the heart line; and thence the forks extend as broader and broader lines to the posterior end of the body. In each segment back of 5 these forks are connected by a whitish bar, already mentioned, just beneath the two median segmental bristles; and more or less by scattered brownish globules between the dorsal segmental bristles.

These bundles of fat, and consequently the amount of brown color, vary considerably in extent in different individuals, or at different times in the same individual. Frequently they cover the entire dorsum except the blood-vessel in segments 10, 11, 12. Usually anterior to this the black body-fluid appears again next the surface in the lateral pockets, already described, entirely surrounded and somewhat interrupted by the adipose mass. The sides of the body appear yellowish white.

When magnified the entire dorsum of the larva is seen to be covered with short, close set black spines. The segmental bristles are larger, but light in color and not conspicuous, about equal in size, situated on slight elevations. Ten of the body segments show twelve such bristles, situated as previously described in *Paragus bicolor.**

The posterior breathing appendages on the dorsum of the last segment, (Figs. 46, *c*; 49; and 50) are short (0.2–0.25 mm. long) and nearly twice as broad (0.4–0.5 mm); divergent for half their length; the dorsal spiracular spines (Figs. 49 and 50, *a*) moderately long, sharply conical, with a very small lateral sub-basal spur. The six elongate spiracles (*b*) are irregularly and considerably curved, about 0.2–0.25 mm. long, the median one on each side nearer to the ventral than to the dorsal one.

The anterior prothoracic spiracles on the third segment (Figs. 46, *b*; 47, *a*) are small, sub-crescent shaped, the lip of the spiracle marked by nine rounded, tooth-like lobes, (Fig. 48).

The head segments bear antennæ, (Figs. 46, *a*; 47, *b*) and mouth parts (Fig. 47, *c*, *d*, *e*). The antennæ are short, fleshy, rudimentary. The mouth parts consist of the usual pair of beak-like jaws (*c*, *d*) and three pairs of mouth-hooks (*e*). The jaws are V-shaped, sharp, slightly hooked at the tip, somewhat shorter than usual, the dorsal extending slightly beyond the ventral when apposed. The latter has a ventrally projecting basal spur on each side. The mouth hooklets are unequal in size the outer pair largest; the other two pairs are situated close beside the jaws, the dorsal ones heavier, the ventral pair small, slender.

To the mouth parts is attached internally a complex system of strong muscles and a broad, chitinous, oesophageal framework (Fig. 51, *d*).

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*The Ohio Naturalist, Vol. XII, No. 1, p. 397, Nov., 1911.

The ventrum of the body is bare; seven pairs of ventral folds of the body-wall making fairly well-defined prolegs.

The larva emerges from the egg very slowly. The anterior end of the egg splits and the sides spread under the contractions and expansions of the larva. Then by stretching out and clinging to some object it pulls itself out little by little. The egg shell is tough rather than rigid and yields to the contortions of the larva.

When first hatched the larvæ are inactive and will lie quietly for hours if undisturbed. If an aphid is forced upon them they will often attack it and attempt to eat it frequently with the result that they are carried away by the larger insect and finally dislodged. However, after the lapse of eight or ten hours the larvæ begin active crawling movements in search of food. Apparently their prey is located not by a chemotropism but by thigmotropism as they frequently pass by an aphid so closely as almost to touch it and go on in search of others. The characteristic movements of these larvæ when searching for food are familiar to many and have been described for another species (*l. c*). Frequently the larvæ grasp first a leg or antennæ of the aphid and cling to it until they can reach the thorax or abdomen.

A young, one-day-old larva barely a millimeter and a half long looks preposterous attacking an aphid fully three times its size. Yet so firmly does the larva cling or become cemented to the surface by its posterior end that the aphid is unable to escape.

These younger larvæ do not eat rapidly. I have at various times observed them in one place sucking the juices of a single aphid for from a half to two-and-a-half hours. Sometimes the aphids continued to struggle for an hour or more.

Growth is rapid. By the end of the second day some of the specimens had reached a length of 7 or 8 mm. and a width of 1.2 mm.

In order to determine something of the capacity of these insects for devouring plant lice and hence their degree of economic importance, the writer tried feeding them with cabbage aphids (*Aphis brassicæ*. Linn.) The aphids were touched to the mouth of a larva which had not been kept from food. A four day old larva devoured the first aphid in 4.5 minutes, a second, third, fourth, and fifth smaller than the first in 2, 1, 1, and 0.5 minutes respectively. The sixth a larger one was retained for 3.25 minutes. These were very thoroughly eaten, all the viscera and body fluids being picked and sucked out. After this the lice tendered were not eaten so closely, but killed, a seventh in 2 minutes an eighth in 1.75 minutes and a ninth in 1.5 minutes.

On another occasion the same test was made with an older larva which devoured a dozen or two before the writer's patience became exhausted. The tests were sufficient, however, to establish the voraciousness of the appetites of these larvæ.

It is, of course, not probable that any larva would ever normally devour aphids so rapidly. Yet when plenty are at hand the number eaten by a larva during its life of eight days to two weeks or more must be very considerable. It should be kept in mind also that it is not the actual individuals eaten, alone, that determines the amount of benefit from these insects; but the fact that in this way the production of enormous numbers of aphids may be prevented. If as Reaumour has calculated, and others have substantiated, one aphid may be the progenitor of over 5,000,000,000 individuals during her existence of a month or six weeks, we can see at once the important benefit that must arise from the destruction of one or two of these aphids early in the establishment of the colony. It is a fact that the eggs of Syrphidæ are often deposited on the host-plant very early or even in anticipation of the arrival of the aphids.

The great factor in determining the duration in the larval stage seems to be the abundance or scarcity of food. Indoors with plenty of food at hand the larval period from emergence from egg to formation of puparium was 8 to 9 days. When less food was supplied this period was extended frequently to two weeks sometimes as much as 20 days. The larvæ are very tenacious of life, some of them existing for over three weeks with very little food.

Out-of-doors the larvæ seem to be little affected by climatic conditions so long as food is available. They endure very wet weather and I have seen them in Autumn survive several periods of cold freezing weather.

In my experience these larvæ may be expected wherever aphids or other soft-bodied insects occur in colonies. They are not restricted to one kind of prey. I have found them most abundantly on cabbage and some other cruciferae at Columbus the latter half of May in an open greenhouse, and out-of-doors in Autumn from the latter part of September to the middle of October; and on Phragmites at Cedar Point from the last week in June to the first week in August.

On cabbage they are very destructive to *Aphis brassicae* Linn. On Phragmites they were predaceous in large numbers on a very abundant unidentified aphid. I have also found them commonly on apple feeding on the European grain aphis (*Siphocoryne avenae* Fab.) during May. Occasionally on curled Dock (*Rumex crispus* L.) and broad-leafed Dock (*R. obtusifolius* L.) among *Aphis rumicus* Linn. the first of June. One of these larvæ was observed devouring a Syrphid larva (*Paragus bicolor* Fab.) from the same host plant. On Black Willow the larvæ parasitized colonies of the Willow Grove Plant-house (*Melanoxanthus soliciti* Harris.) on the University campus the first half of October.

On these plants the position of the larvæ is determined by that of the aphids. On cabbage they are largely on the under side of the outer drooping leaves but may be found well in among the more compact leaves of the head. On Phragmites they are mostly on the upper, but also on the under side of the long linear leaves; on *Rumex* spp. chiefly among the flower spikes, and lower leaves; and on apple and willow on the outer small and tender twigs.

Parasites.

I have noted one very bad enemy of *Syrphus americanus*—the Ichneumonid parasite, *Bassus laetatorius* Fabr. I have reared this species from larvæ and pupæ not only of *S. americanus* but also of *Paragus bicolor, Paragus tibialis, Allograpta obliqua*, and *Sphaerophoria cylindrica.*

It appears most abundantly on *S. americanus* especially during midsummer, July and August, on Phragmites and again in September to November on specimens from cabbage. At times I have found fully 75% of those collected were destroyed by this parasite. I have not reared the parasite from specimens taken previous to July.

This parasite oviposits through the body wall of the larvæ, the eggs hatch and the larvæ develop without preventing the formation of a more or less complete puparium by the host. Within the puparium the development of the larval parasite goes on at the expense of the Syrphid. The latter is entirely devoured and the parasitic larva reaches in size nearly the capacity of the puparium. Pupation then takes place and the adult emerges by gnawing a small irregular hole in the anterior end of the dipterous puparium about 3 or 4 weeks after pupation of the host. Only one parasite develops in each host individual.

The larvæ when full grown measure about 4 mm. in length by 1.8 mm. in height, by 2 mm. in width. They are plump, whitish, erusiform, ovate in outline; median segments largest, humped dorsally and with the posterior end smaller than the anterior. As their orientation is the same as that of the puparium it will be seen that the full grown larva fits very nicely, in size and shape, the puparium of the host. There are 14 body-segments clearly shown; the only conspicuous appendage is a U- or V-shaped chitinous piece in the region of the mouth. Sketches of a larva and a pupa are given as Figures 58, 59.

The adult may easily be recognized by the following description from G. C. Davis' "A monograph of the Tribe Bassini" Trans. Am. Ento. Soc. XXII, p. 19, Feb. '95, who also states that it is one of the most common and wide spread species in Europe and America.

"♀. Length 6 mm. Head, thorax, base and tip of abdomen, hind tarsi, base and lower middle of hind tibiæ black; four anterior legs, posterior coxæ, femora, and often tips of tibiæ, tip of abdominal segment 1, whole of 2 and 3 and more or less of 4, rufous; anterior orbits, mouth, tegulæ, spot in front, line beneath, cuneiform spots on mesonotum, scutellum, post-scutellum, and band on posterior tibiæ white.

♂—Differs only in having the face, scape beneath and a stripe on pleura yellowish white."

As previously pointed out for *Paragus bicolor* (*l. c.*) the presence of the parasite is usually indicated at the time of pupation by a failure of the puparium to inflate completely anteriorly and dorsally, and retract on the ventral side, and also by its darker color. The following are the average dimensions of 15 puparia from which *Bassus lactatorius* had emerged: length 6 mm., height 2.25 mm., width 2.45 mm. Compared with the dimensions of an equal number of unparasitized individuals as given below, it will be seen that these are slightly less in all dimensions than the normal ones, with a little more difference in height than in length or width. The difference in shape is more conspicuous than these figures would indicate (See Fig. 56) and together with the difference in color makes them rather easy to distinguish when once the characteristics are learned.

As suggested in the previous paper it ought to be easy to accomplish a great deal of good by destroying these parasitized puparia before the parasite emerges.

Puparium.

Dimensions, average of 15: length 6.5 mm., height 2.5 mm., width 2.6 mm. (Fig. 55). Pupation occurs within the indurated larval skin after shortening and dorsal and lateral inflation especially at the anterior end. The head segments are retracted ventrally so that segments 3 to 5 lie at the anterior pole and the tip of the mouth-parts (terminal in the larva) are about 0.5 cm., back on the ventral side. The wrinkling of the skin, characteristic in the larva is largely lost, due to the inflation. The vestiture remains as in the larva, the segmental spines inconspicuous, but the exposed parts of the wrinkles of the larva, densely covered with very small, short, sharp, black spines. Sometimes this gives a rather prominent transverse banding of black where the spines are thickest.

The posterior three segments are proportionately less inflated than the middle ones. Shape from dorsal aspect ovate with the last segment and its respiratory appendage projecting; very slightly broadest in front of the middle, nicely rounded out in front. From the side (Fig. 56) the anterior and dorsal inflation

is evident; the puparium is not strongly elevated posteriorly, being convexly depressed gradually from about the middle. From in front the puparium appears nearly circular in outline, very slightly flattened ventrally.

The posterior breathing appendage (Fig. 55, *a*) is as in the larva but entirely black, the segment inflated beneath it. The anterior spiracles remain visible externally, antero-dorsal to the tip of the mouth-parts, with parts of the tracheæ leading from them visible flattened against the inside of the puparium (Fig. 51, *a*). The larval mouth parts also become flattened against the puparium on their right or left side. (Fig. 51, *b*, *c*, *d*). At first the pupa shrinks away from these parts but later as the adult head develops fills up the space again. A line of weakness develops in the puparium running from the apex of the mouth-parts dorsally between segments 6 and 7. The expanse of the ventral part of the face then forces off a circular operculum along this line for the emergence of the adult. Posteriorly part of the large tracheal trunks remain in connection with the spiracles.

Color of the puparium, empty: pale brown, transparent; with pupa enclosed: variable, darker brown, strongly tinted with salmon. A day or two before emergence the prominent colors of the adult become plainly visible.

Pupa.

The coarctate pupa (Fig. 54) is covered with a delicate transparent membrane (*a*) with pockets encasing the developing legs, wings, etc. The changes visible externally are gradually produced and give little indication of the radical internal histolysis and histogenesis.

At an early stage (Fig. 53) when the dorsal part of the abdomen is simply a mass of fatty granules as in the larva with the position of the dorsal blood vessel indicated and the head and thorax irregular, angular masses; the legs, or the cases enclosing them (Fig. 53, *a*, *b*, *c*) have already reached their full size; although there is no vestiture developed on them and their outline and segmentation are indefinite. The wing-pads, also, (*d*), are as large as they will become before emergence but show no signs of the venation which is prominent at a later stage. They are folded ventrally about the sides of the body.

The mouth-parts are visible as long, cylindrical, fleshy buds (*e*). The eyes are not indicated externally except as irregular oval areas about half the size of the adult eye antero-dorsal in position, bounded by a slightly elevated ridge.

A considerably later stage shows the abdomen still cylindrical without color and with only a little vestiture, the segments faintly indicated by constrictions, the fatty granules gone. The head is

well developed, the eyes pale but full sized, the facets faintly marked. The ocelli are white, rounded projections. The antennæ full-sized but colorless, bent ventrally, arista pale extending laterally. The thorax is hardly fully expanded, pale fleshy, the vestiture very faint. A decided flexure at the junction of thorax and abdomen throws the scutellum beneath the anterior part of the abdomen.

The mouth-parts are short, thick, fleshy cylinders. The eyes approach each other at the lower part of the head more closely than in the adult. The legs are definitely segmented and of definite outline the vestiture and claws pale. The femora extend antero-laterally, the fore and middle tibiæ and tarsi postero-medially parallel to the femora. The hind tibiæ however develops a strong flexure (Fig. 52, *a*). This leg is bent up under the wing-pad and back, the tarsus projecting to the tip of the abdomen on the median ventral line. The tibia is bent beyond the middle at an angle of 150° thus shortening the extent of the leg posteriorly.

The wings are pale and fleshy but show the development of the adult venation. There is a prominent U-shaped loop about the middle of the costal margin and the rest of the wing is very much crumpled and folded.

In a later stage (Fig. 54) very shortly before emergence, the dark reddish-brown color of the eyes and the black and yellow banding of the abdomen showed clearly; the vestiture was well developed and the shape and segmentation that of the adult with the following exceptions: The scutellum is broader and flatter than in the adult condition, the thorax fleshy, without any of the adult coloring, but with the vestiture well developed, showing three longitudinal bands. The mouth-parts are fleshy, flattened, unextended. Wings much as in the earlier stage but with hairs on the margin, veins black. The two wing membranes are not apposed and much corrugated, blue-gray in color.

Since the generations are considerably confused during any season, the date of pupation can be stated only in a general way. This may be inferred from the dates given for the occurrance of the larvæ. In experiments indoors from the first eggs deposited in spring, I secured pupæ on May 22. Winter is sometimes passed in the pupa stage but whether this is the only method of wintering I cannot say.

This stage is for the most part passed in the same location as the larval. I have found puparia glued by the posterior segment to leaves of cabbage and among flower- and leaf-axils of *Rumex crispus*. Some of the specimens kept on potted cabbage, were found as pupæ buried under a half inch or more of the soil in the pot. The puparium becomes very hard and more or less impervious.

Adult.

Description after Wiedemann, Auss, Zw. Ins. II, 129, 22, and Osten Sacken, Proc. Bost. Soc. Nat. Hist. XVIII, 145.

♂, ♀. Length 8–10 mm. Female. Face yellow, in certain positions with a pearly luster, *with a brown stripe* in the middle, which begins at the oral margin but does not reach the antennæ; the latter brownish-black, reddish on the underside of the third joint. Cheeks blackish, *but separated from the mouth by a narrow yellow border*, which on the underside of the mouth completely cuts off connection between the black color on both sides. Front brownish bronze color, powdered with yellow on each side. Immediately above each antenna there is a brownish spot sometimes continued above into an indefinite black stripe; vertex metallic bronze or black, eyes bare. Thorax metallic greenish black, unstriped; with scattered luteous pile; on the sides, in front of the base of the wing, yellowish; elsewhere metallic green; scutellum metallic yellow, with a bluish reflection and sparse yellow pile. First abdominal segment metallic blue; the rest of the abdomen black with bright yellow cross-bands. The first abdominal cross-band is not interrupted but co-arctate in the middle; its ends do not touch the margin of the abdomen, but are separated from it by a narrow black border; sometimes a brownish mark in the middle of this band gives it the appearance of being sub-interrupted. The second cross-band is nearly as broad as the black cross-band between it and the next yellow band; it is usually perfectly straight (in some specimens the hind margin is gently sinuate); its ends do not touch the lateral margin of the abdomen; they are cut obliquely, forming a sharp angle anteriorly, and a rounded one posteriorly; the former almost touches the margin of the abdomen. The third band is similar to the second, only its hind margin is more perceptibly arcuated. The posterior margin of the fourth segment has as usual, a narrow yellow border; the fifth likewise, and two yellow spots at the base besides. Femora yellow; the four anterior ones in some specimens brownish at the extreme base only; the hind pair with a more or less dictinct brown ring on the distal half; four anterior tibiæ and tarsi yellow; the hind tibiæ sometimes with a brownish ring, the hind tarsi brownish.

Male (Fig. 44). Front yellow, with a more or less distinct brown spot above each antenna; cross-bands on the abdomen broader than in the female, and distintly broader than the black interval between them; posteriorly, they are often nearly straight, sometimes distinctly arcuate, especially the third band. The yellow spots on the second segment are not coalescent, but separated by a narrow black interval (in some specimens sub-coalescent); the fifth segment is yellow, with a black spot in the middle. The four anterior femora are black at the base; the hind femora

are usually black, with a yellow tip; sometimes there is a trace of yellow at the base; hind tibiæ usually with a brown ring in the middle.

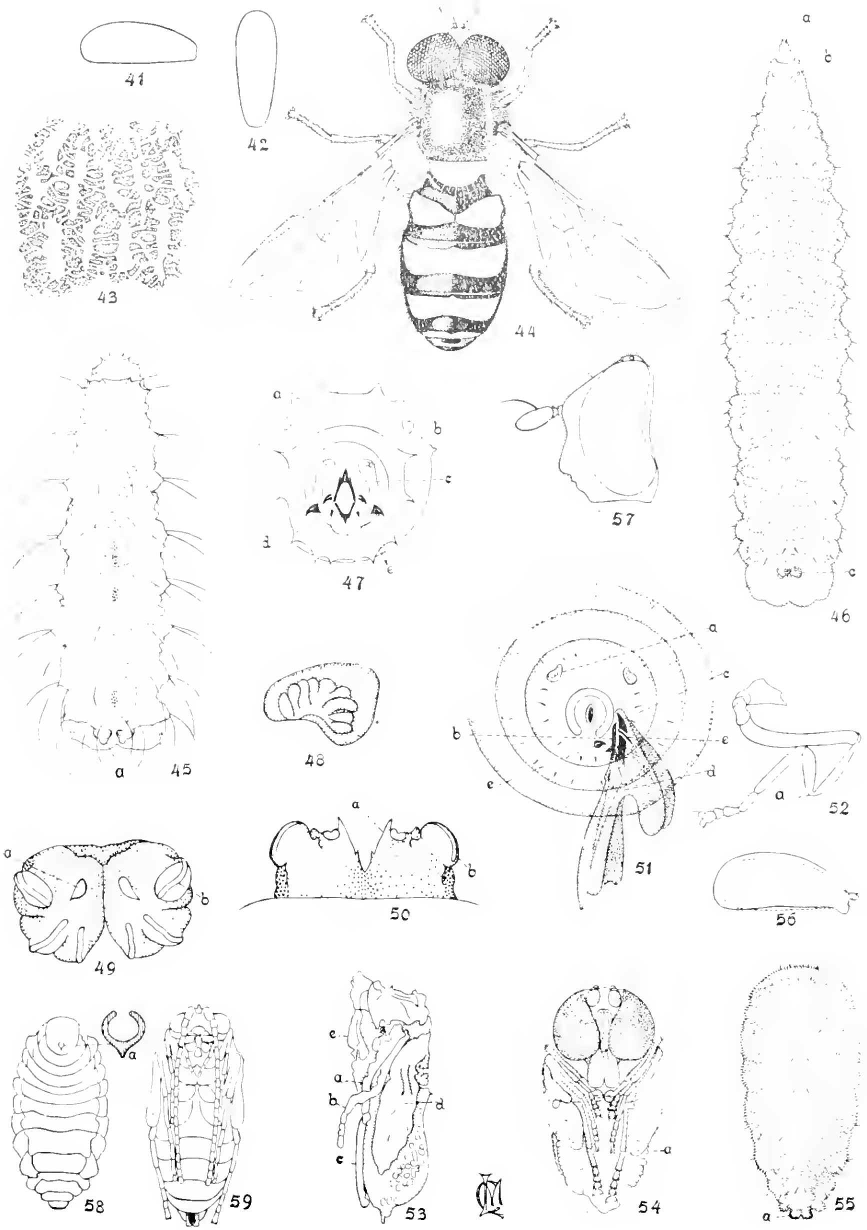
The adults have been taken in large numbers about blossoming willow (*Salix* sp.) as early as the last few days of March and the first of April, and again about blossoming apple and pear, the first of May. They are abundant in mid-summer and can be taken about all kinds of blossoms.

They are pollen and nectar feeders and doubtless of considerable importance as pollenizers of fruit trees and other plants. For this, and their work in checking aphids, they are worthy every protection that can possibly be afforded them.

EXPLANATION OF PLATE XXIII.

Fig. 41. Egg from the side x 17.
Fig. 42. Dorsal view of egg x 17.
Fig. 43. A small part of the surface of egg-shell showing sculpturing, highly magnified.
Fig. 44. Adult ♂ about 5 times natural size.
Fig. 45. Larva just hatched x 50; *a*, posterior respiratory appendage.
Fig. 46. Full-grown larva x 7; *a*, antenna, *b*, anterior spiracle, *c*, posterior respiratory appendage.
Fig. 47. Anterior view of larva, much enlarged, showing mouth-parts, antennae, etc.; *a*, right anterior spiracle; *b*, antenna; *c*, upper jaw; *d*, lower jaw; *e*, the three pairs of mouth-hooks.
Fig. 48. Dorsal view of right anterior spiracle, highly magnified.
Fig. 49. End or posterior view of posterior respiratory organ x 55; *a*, dorsal spiracular spine; *b*, one of the three pairs of slit-like spiracles.
Fig. 50. Side or dorsal view of posterior respiratory organ x 55; lettering as in Fig. 49.
Fig. 51. Appearance of a part of the puparium externally in the region of the mouth-parts much enlarged; *a*, right anterior spiracle with short piece of trachea attached; *b*, lower jaw of larva; *c*, upper jaw of larva; *d*, chitinous oesophageal framework; *e*, mouth-hooks of larva.
Fig. 52. Hind leg of pupa showing flexure of tibia at *a*.
Fig. 53. An early pupal stage from the side; *a*, *b*, and *c*, developing legs; *d*, wing-pad; *e*, mouth-parts.
Fig. 54. A much later pupal stage, ventral view; *a*, the delicate investing membrane.
Fig. 55. Dorsal view of puparium x 5; *a*, posterior respiratory organ.
Fig. 56. Outline of puparium from the side. The dotted outline is given to show the typical shape of a parasitized puparium.
Fig. 57. Lateral view of head of female x 7.
Fig. 58. Larva of parasite, *Bassus laetatorius*, mouth-parts at *a*, ventral view.
Fig. 59. Pupa of *B. laetatorius*, ventral view.

Figs. 53, 54, 58, and 59 each about 5 times natural size.



Metcalf on "Life-Histories of Syrphidae III."

A REVISED TAXONOMY OF THE GRASSES.[1]

JOHN H. SCHAFFNER.

Having had occasion to study the grass flora of Ohio in connection with the preparation of a forthcoming catalog of Ohio plants and having paid considerable attention to the phyletic arrangement of the flowering plants, it soon became evident to the writer that the usual arrangement, as given in recent systematic works, reverses the order of nature and the rational method of presentation. To begin the grass series with plants having such specialized structures as one finds in Zea, Coix, and Tripsacum, is to intimate that the grasses have been evolving from the specialized to the unspecialized, from the unique to the normal, from the particular to the general.

If one makes a general study of the spikelet and flower, the order of progress is indicated in a remarkably clear manner by a long series of degenerations and vestigial parts. The evidence is incontrovertable to anyone who can entertain any modern views on the doctrine of evolution as applied to these plants. The conclusion seems inevitable—the bamboos and arundinarias are the most primitive grasses while gama-grass, Job's-tears, and Indian corn are among the most extreme specializations to be found not alone in the Graminaceae but even in the whole group of flowering plants.

In order to present the arrangement clearly to students of systematic botany, a brief description of the terminology, with a synopsis of the tribes usually recognized and a systematic list of the local genera, is given below.

TERMINOLOGY OF THE GRASS INFLORESCENCE

The inflorescence of a grass is made up of compact flower-bearing branchlets known as spikelets. In general, the spikelet of a grass is of the same importance in identification as the flower in most other groups. The spikelet usually has two bracts at the base which are called the *empty glumes*. These may be distinguished as the *outer* and *inner empty glumes*. Each flower is also normally inclosed in two bracts, called the *flowering glumes*. The outer of these glumes is called the *lemma* the inner the *palet*. All of these bracts can thus be called *glumes* collectively. Through reduction of the spikelet and degeneration of the flower, part of the glumes may be absent or vestigial, or extra glumes may be present. Usually there are 2 (sometimes 3) minute bracts or scales at the base of the flower, within the flowering glumes. These

1 Contributions from the Botanical Laboratory of Ohio State University, 67.

are called *lodicules* and are supposed to represent a vestigial perianth.

The synopsis given below corresponds quite closely with that of Bessey, given in his "Outline of Plant Phyla, Second Edition." I might add however, that my own arrangement was worked out independently several years ago before I knew that Dr. Bessey was working on the same problem. To anyone interested, a comparison of the two synopses will indicate in some degree the basis on which phyletic classification rests and the extent of agreement to be attained by workers not influenced by nor following any adopted "authority."

SYNOPSIS OF THE TRIBES OF GRASSES.

I. Spikelets many—1-flowered; rachilla usually articulated above the empty glumes which are persistent after the fall of the flowers; spikelets usually more or less laterally compressed.

1. Aerial stems entirely woody or at least woody at the base, perennial; lodicules usually 3; leaf-blade with a short petiole articulated with the sheath.
Subfamily, **Bambusatae.**
a. Tribe, *Bambuseæ.*

2. Aerial stems herbaceous and annual; lodicules usually 2; leaf-blades sessile, without a joint.
Subfamily, **Poacatae.**

(1). Spikelets 2—many-flowered; in panicles, spike-like panicles or racemes.

a. Flowering glumes as long or longer than the empty glumes, unawned or with a straight awn from the apex. Tribe, *Festuceæ.*

b. Flowering glumes generally shorter than the empty glumes, usually with a bent awn on the back; callus and usually the rachilla-joints hairy.
Tribe, *Aveneæ.*

(2). Spikelets 1—several-flowered, in rows, forming an equilateral or 1-sided spike or raceme; sometimes monosporangiate.

a. Spikelets sessile in 2 opposite rows, forming an equilateral spike; leaf-blades bearing at base a more or less well-marked pair of auriculate appendages. Tribe, *Hordeæ.*

b. Spikelets sessile in 2 rows on one side of a flattened axis, forming 1-sided spikes which are digitate or paniculate, or sometimes solitary.
Tribe, *Chlorideæ.*

(3). Spikelets with but one perfect flower, or monosporangiate; always in panicles or racemes, not in rows.

a. Spikelets with 4 or more glumes.

(a). Third glume enclosing a perfect flower just above the empty glumes; palet of the perfect flower usually 2-nerved. Tribe, *Agrostideæ.*

(b). Fifth glume enclosing a perfect flower on the top of the spikelet; palet of the perfect flower usually 1-nerved or nerveless.
Tribe, *Phalarideæ.*

b. Spikelets usually with but 2 glumes, or the lower empty glumes reduced; spikelets often monosporangiate. Tribe, *Oryzeæ.*

II. Spikelets usually 2-flowered or by degeneration 1-flowered; rachilla articulated below the empty glumes which are thus deciduous with the flowers; spikelets more or less dorsally compressed; aerial stems annual.
Subfamily, **Panicatae.**

1. Flowering glumes, at least of the perfect flowers, similar in texture to the empty glumes, or frequently coriaceous or chartaceous (indurated), never thin and hyaline.

a. Flowering glumes of the perfect flowers chartaceous or coriaceous, very different from the empty glumes.
Tribe, *Paniceæ.*

b. Flowering glumes membranous.

(a). Inflorescence paniculate, spikelets deciduous singly from the ultimate branches; first empty glume usually smaller and narrower than the rest.
Tribe, *Tristegineæ.*

(b). Inflorescence spikate; spikelets deciduous singly or in groups; first empty glume usually larger than the rest, the second one often spiny.
Tribe, *Zoysieæ.*

2. Flowering glumes thin and hyaline, much more delicate in structure than the thick-membranous or coriaceous empty glumes.

a. Spikelets in pairs, one usually sessile the other pedicellate, the sessile spikelet with a perfect flower, the pedicellate one with a perfect, staminate, or sterile (vestigial) flower; lemmas of the perfect flowers usually awned. Tribe, *Andropogoneæ.*

b. Spikelets monosporangiate, in separate inflorescences or in different parts of the same infloresence, the carpellate portion or inflorescence below, the staminate above; lemmas awnless.
Tribe, *Maydeæ.*

SERIAL LISTS OF THE LOCAL GENERA OF GRASSES.

Festuceæ.

Bromus.
Uniola.
Melica.
Festuca.
Panicularia.
Poa.
Dactylis.
Eragrostis.
Eatonia.
Koeleria.
Korycarpus.
Tricuspis.
Triplasis.
Cynosurus.
Phragmites.

Aveneæ.

Danthonia.
Arrhenatherum.
Trisetum.
Avena.
Deschampsia.
Aira.
Holcus.

Hordeæ.

Lolium.
Agropyron.
Triticum.
Secale.
Elymus.
Hystrix.
Hordeum.

Chlorideæ.

Spartina.
Beckmannia.
Capriola.
Eleusine.
Atheropogon.
Bouteloua.

Agrostideæ.

Sporobolus.
Calamagrostis.
Agrostis.
Apera.
Cinna.
Ammophila.
Alopecurus.
Heleochloa.
Phleum.
Muhlenbergia.
Brachyelytrum.
Milium.
Oryzopsis.
Stipa.
Aristida.

Phalarideæ.

Savastana.
Phalaris.
Anthoxanthum.

Oryzeæ.

Homalocenchrus.
Zizaniopsis.
Zizania.

Paniceæ.

Panicum.
Syntherisma.
Echinochloa.
Paspalum.
Chaetochloa.
Cenchrus.

Andropogoneæ.

Sorghum.
Sorghastrum.
Manisuris.
Andropogon.

Maydeæ.

Tripsacum.
Coix.
Zea.

OHIO MOLES AND SHREWS.

Jas. S. Hine.

The Ohio members of the Order Insectivora, commonly called moles and shrews, have been quite extensively collected in the state and some things in regard to their habits and distribution may be said. The moles are easily distinguished from the shrews by their larger size and wider front feet. Three of each have been taken and there is a possibility that other species of shrews exist within our territory, at least the adjoining states that have published lists of mammals all enumerate more than three, but as Ohio is between the East and the West from the faunal standpoint one is not surprised when some of the species listed from Pennsylvania and Indiana are not taken.

The common or short tailed shrew, Blarina brevicauda, is the most abundant species of the order in the state. Trapping in any section and under various conditions is sure to reveal this species at the outset and it continues to appear in the traps day after day until the collector, who is always desirous of variety, feels more or less disgusted and resolves to try another locality only to find the same condition of things. Deep woods, open fields, high or low grounds seem to attract it, in fact, one is not able to name a single place where it may not be found.

This little animal is near the size of the common house mouse and is largely carniverous in its feeding habits. Some authors state that habitually it never takes vegetable food. Insects of various kinds are taken in large numbers, angle worms and snails are eaten commonly and small rodents, like mice of some species, often lose their lives to satisfy its insatiable appetite. Shull has given a very full account of the short-tailed shrew in the American Naturalist from observations taken at Ann Arbor and one should read this paper in order to know the ecomonic value of the species. Since mice and injurious insects are so often used as food by it the amount of good done is considerable and since it is not known to eat anything of special value we should consider this shrew almost wholly beneficial and worthy of consideration.

The shrews do not have the habit of heaving the ground to the same extent as the moles and consequently are not considered particularly injurious from that standpoint. Although the common shrew is so abundant and found in every section of the state it is not seen usually by people who are not looking for it. Its retiring and more or less nocturnal habits prevent it from being seen often, and the odor which is associated with it is more or less of a protection from some animals which would otherwise prove

to be its serious enemies. Hawks and owls as well as various species of snakes are known to feed upon the common shrew occasionally but it seems that this animal, although so abundant, is not used as food by various carniverous animals to the extent that is the case with some of the small rodents.

The least shrew, Blarina parva, appears to be present in most parts of Ohio as it has been observed and taken in Ashtabula, Summit, Franklin and Hamilton counties. The appearance of the species in Ashtubala county is of interest as most authors do not record it so far north. R. J. Sim, who lives at Jefferson, states that he usually sees three or four each year without making special efforts to find them, so it is not particularly rare. In Summit county numerous specimens have been taken and some of them are in the museum at the University.

The long-tailed or masked shrew, Sorex personatus, has been taken in Mahoning and Ashtabula counties only, but from its range in adjoining states, probably exists in other sections but on account of its retiring habits and small size has been overlooked.

The prairie mole, Scalop aquaticus machrinus, is known to be distributed quite generally over western Ohio. It is a subspecies of the common mole of eastern United States east of the Allegheny Mountains. Rhodes studied the fauna of Pennsylvaina west of the Allegheny Mountains very carefully without finding evidence of the existence of either the common mole or its subspecies. Since the prairie mole is known to be very common in western Ohio from Michigan to the Ohio River, the eastern limit of this subspecies falls within the state and so we are interested in determining the most eastern station where specimens have been taken. It is well known from Columbus but in the vicinity of Akron where I have collected quite extensively it has not been taken. Because one does not take a certain species in a locality is not always conclusive proof that it does not occur but on the other hand the distribution of animals is stated from the actual evidence procured and this evidence points towards the conclusion that the mole in question does not appear in Summit and Medina counties but is replaced by the two other species of Ohio moles, both of which have been taken. It is very desirable that persons finding any of the moles and shrews in their localities, let the facts be known so that some of these questions of distribution may be better understood.

The very peculiar star-nosed mole, Condylura cristata, is known to be a resident of Ohio by the capture of more than a dozen specimens, including one taken as late as 1910. Summit county can claim most records, for at least nine specimens have been captured in this county as the records kept by Eugene F. Cranz, of Ira, show. The species is known from Ashtabula,

Cuyahoga, Richland and other counties, and if the facts were known I suspect it occurs throughout northern Ohio, at least wherever suitable conditions are to be found.

The hairy-tailed or Brewer mole, Parascolops breweri, is abundant in some parts of eastern Ohio where its injuries to lawns and gardens compare favorably with the work of the prairie mole in the western part of the state. Records of the occurrence of the species are at hand from Cuyahoga, Summit, Franklin and Adams counties which so far as known marks what has been considered somewhere near the western limit of the range of the species, although recently Hahn mentions it in his Mammals of Indiana and says that the occurrence in that state is not beyond the range of possibilities. I would like to know of any records which extend the known distribution of this mole westward from the line indicated by the counties named.

It develops therefore that the known records of Ohio moles give each species a somewhat definite distribution in the state and that so far no locality is known to have all three although two are known from various places.

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THE NORTH AMERICAN LYCOPODS WITHOUT TERMINAL CONES.

JOHN H. SCHAFFNER.

There has been some hesitancy among fern students in recognizing the validity of Lycopodium porophilum Lloyd and Underwood as a species. By some it is regarded as a variety or form of L. lucidulum Mx. This is probably due to the intermediate character of the juvenile forms. Mature plants of L. porophilum, however, as determined by the writer resemble L. selago L. more closely. In Ohio one can collect either form without difficulty and numerous specimens have been sent to the Ohio State Herbarium. The species was reported for Ohio by the writer in the spring of 1905 (OHIO NAT. *5:* 301) as occurring in Fairfield county. In December, 1906, while in New York the matter was discussed with Dr. Underwood himself and a careful examination was also made of the original specimens at the New York Botanic Garden. Since that time the Ohio plants have been L. porophilum to the writer and the species a good species.

Underwood's description in "Our Native Ferns and their Allies, Sixth Edition, Revised" defines the typical Ohio specimens very well and also gives the characterization of the two related species correctly in their typical form, although it does not emphasize the character of the general habit. Condensations of the species, descriptions are as follows:

Lycopodium porophilum. Leaves flattened at their bases and ultimately more or less reflexed. *Prostrate portion of stems short,* abundantly rooting, curving upwards, *then dichotomously branching 1–3 times to form a rather dense tuft (2–4 in. high) of vertical stems, densely clothed with spreading or reflexed leaves;* leaves entire or very minutely denticulate. Sandstone rocks.

Lycopodium lucidulum. Leaves flattened at their bases and ultimately more or less reflexed. Prostrate portion of stem longer, frequently rooting, curving upward, and dichotomously branching 1–3 times to form *a loose cluster 4–8 in. high.* Margin (of leaf) erose denticulate above the middle

Lycopodium selago. Leaves hollow at their bases and appressed. *Prostrate portion of stem very short,* abundantly rooting, soon curving upward and dichotomously branching to *form compact tufts (2–7 in. high) of vertically placed branches with dense foliage;* leaves more or less appressed, or at least upwardly directed, entire.

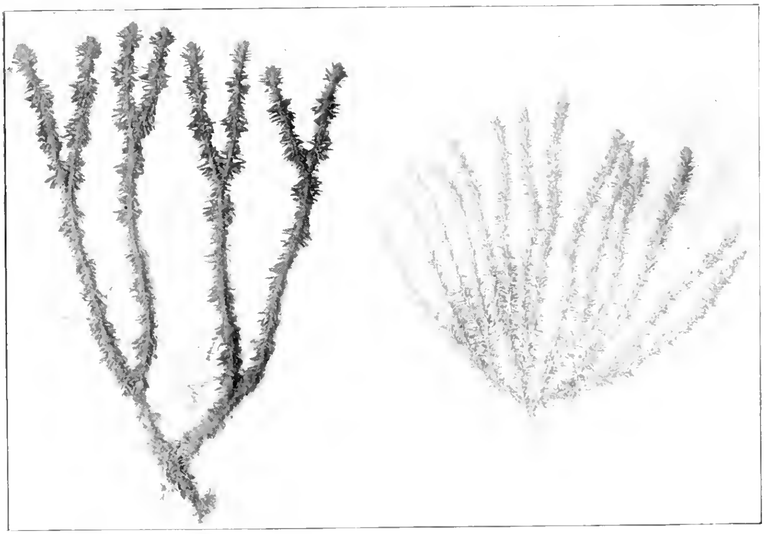


Fig. 1. Lycopodium lucidulum, Hocking County, Ohio.
Fig. 2. Lycopodium porophilum, Fairfield County, Ohio. Photograph by Forest B. H. Brown.

The accompanying figures are given as representative specimens of the three species. The L. lucidulum was collected in Hocking county, while the L. porophilum comes from Fairfield county. L. lucidulum is *successively dichotomous* in habit *at rather regular intervals;* L. porophilum is *several times dichotomous in close succession* with *long unbranched branches.* The leaves agree with Lloyd and Underwood's descriptions.

There has been some question as to whether the Ohio forms referred to L. porophilum might not be L. selago. In order to gain an insight into the character of the European L. selago, the specimens at the United States Natural Herbarium were studied. Through the kindness of Mr. W. R. Maxon, an English specimen and an Alaskan specimen were loaned to the writer for special study.

Photographs of what are regarded as typical examples are here presented. The English plant was from Tilgate forest, Sussex. Both the American and European plant show plainly that the branching habit of L. selago is similar to that of L. lucidulum. The branching is a *successive dichotomy at rather regular intervals.* In the European specimens the leaves are smoother and more rigid in appearance than in the Alaskan plants. In the Alaskan specimens the leaves are slightly crinkled and not so rigid and the surface has a silky-glossy appearance. Specimens in the Ohio State Herbarium from Europe and from the Roan Mountains of North Carolina show the same differences. The Ohio specimens of L. porophilum do not show the crinkled character nor the silky-glossy surface of the American L. selago. Although there is a slight difference between the American and European L. selago, it is too insignificant to be considered.

Fig. 3. Lycopodium selago, from Tilgate Forest, Sussex, England.
Fig. 4. Lycopodium selago, from Alaska. Photograph by Forest B. H. Brown.

L. porophilum is readily distinguished from L. selago by its mode of branching and by its reflexed lower leaves. Mature specimens seem, however, to be frequently included with L. selago in collections.

As stated above, incorrect determinations may easily be made from young specimens, but the recapitulation of ancestral characters does not invalidate a species that is well differentiated at maturity. The figures presented above show that we have in America three very characteristic forms of the group of Lycopods under consideration each of which is distinct enough to be regarded as a valid species.

SOME ENTOMOPHILOUS FLOWERS OF CEDAR POINT, OHIO.

ALLEN C. CONGER.

In a region with such a diverse flora, and where even the casual observer is struck by the great numbers of Hymenoptera (bees) and Diptera (flies), it is but natural that the study of those flowers depending upon insects for pollination should prove interesting and instructive. The observations which form the basis for this article were made during the summer of 1911 under the direction of Dr. O. E. Jennings, Instructor in Plant Ecology at the Lake Laboratory, Cedar Point, Ohio, and his suggestions have been of great aid. Reference has been freely made to books at hand, especially to the "Hand-book of Insect Pollination" by Knuth.

Sir John Lubbock and Hermann Mueller state that blue flowers are the favorites of bees and the occurrence in this region of a fauna, rich in Hymenoptera, especially the solitary forms, and a flora marked by many blue and violet flowers, especially in or near the sandy spots chosen by the bees for their burrows would tend to confirm this theory.

Labiates and others alike show a remarkable similarity in the relative positions of stamens and stigma. The majority of types under consideration possess two pairs of stamens of unequal length, the outer pair being the longer. In nearly all cases the anthers are found in the upper lobe of the two-lipped corolla, this being the most advantageous position for scattering pollen upon the insect visitor. In addition, such a position makes difficult the stealing of pollen by unwelcome visitors, especially the creeping forms. The styles, especially in the Labiates were found to elongate with age and undoubtedly in some cases self-pollination could occur as the stigmatic surface was being pushed past the anthers.

The species, with one exception are found in Knuth's Class 4, Flowers with Concealed Nectar. This class of flowers shows much zygomorphism, thus indicating a high degree of flower specialization. Reds, blues, and violets are the predominating colors as opposed to the whites and yellows of the flowers with more exposed nectar. The higher degree of specialization in the flowers calls for a corresponding advance in the specialization of their visitors. The nectar can be conveniently sipped by short-tongued bees and long-tongued wasps, as well as by certain of the Diptera (Bombylidae and Syrphidae) and a number of the Lepidoptera. This is more difficult for the shorter tongued flies (Muscidae) and for the same reason the beetles are very infre-

quent visitors. A comparison with the observations of Bembower, made in the summer of 1910, shows a remarkable but not unexpected contrast in the type of insect visitors noted. The shorter-tongued flies and the flower beetles (Donacia and Diabrotica) were not observed on the flowers under consideration in this report, while in the white and yellow forms studied by Bembower these were almost invariable visitors. Undoubtedly some of the flowers under consideration are hymenopterid flowers, that is, flowers modified especially for the Hymenoptera. Knuth states (Hand-book of Insect Pollination, Vol. I, p. 117) that in the case of flowers with completely concealed nectar, accessible to bees, similarly colored species are in flower, together. This was especially noteworthy in the case of Stachys, Teucrium, Verbena, and Mimulus, as described below.

Nearly all the species observed were found to be protandrous, which appears to be a common method for preventing self-pollination in entomophilous flowers.

Labiatae (Mint family.)

Blephilia ciliata.

Found here, growing in communities closely associated with Nepeta cataria (catnip) this bluish-purple flower, though small in size, the corolla tube being about 9 mm. in length, is conspicuous because of the dense, globose whorls of the inflorescence. The corolla is nearly equally two-lipped; the upper lip entire, the lower three-cleft, the lateral lobes rounded and longer than the middle one. The throat of the corolla tube is dilated and here are found the style and anthers, the former slightly exceeding the latter in length.

Visitors—Diptera; Syritta pipiens; Hymenoptera; Microbembex monodonta, Agapostemon radiatus, A. splendens, Odynerus forminata, Bombus virginicus, B. fervidus, Megachile latimanus: Lepidoptera; Pieris rapae.

Stachys tenuifolia, var. aspera.

Found along the shores of the coves and marshes, closely associated with Teucrium. The lilac or pinkish corolla is bilabiate, the upper lip arched and entire, the lower lip longer and spreading, three-lobed, with the middle lobe entire and marked by a darker colored nectar guide. Nectar is secreted at the base of the ovulary and stored in the smooth lower part of the corolla tube, which is 8 mm. long. The flowers are protandrous. The four stamens are in two pairs of unequal length, the outer dehiscing first, followed by the shorter, inner pair. The former then diverge so that they project laterally between the lips of the corolla. The style elongates with age, so that the stigma lobes are brought to the mouth of the flower, thus receiving pollen from the dorsum of the larger insect visitors.

VISITORS—Diptera; Sphaerophora cylindrica: Hymenoptera; Microbembex monodonta, Agapostemon radiatus, Odynerus foraminata, Bombus fervidus, B. affinis, Andrena carlini, Megachile latimanus.

Teucrium canadense.

This species, which varies in color from cream to purple, is common along the shores of the coves in this region. It was observed that the species was closely associated in habitat with Asclepias incarnata (swamp milk-weed), a flower of about the same hue, and insects were seen to be attracted first to the Asclepias, then later to visit the Teucrium.

The corolla is very irregular, the four upper lobes are approximately equal in size, but so placed and directed forwards that there appears to be no upper lip, the lower lip is larger and forms a convenient landing-place for insects. The four stamens are unequal in length, the outer pair exceeding the inner by about 3mm. The style, which lies between the inner pair is approximately the length of the outer pair, but curves less, so that without external causes self-pollination would not occur.

The larger bees alight on the lower corolla lobes and insert the proboscis at either side into the corolla tube. As the bee's head is pushed down into the corolla the anthers are brought into contact with the dorsal part of the visitor's thorax, which in many bees is distinctly pilose, and thus pollen is dusted off. Since this could hold true for larger insects, the writer does not believe that smaller Hymenoptera or Diptera are important factors in cross-pollination. Several smaller species of Hymenoptera and Syrphidae were observed to alight directly on the anthers, grasping the filaments for support, and possibly in this way could affect cross-pollination.

VISITORS—Diptera; Syritta pipiens, Allograpta obliqua, Syrphus americana, Eristalis tenax: Hymenoptera; Agapostemon radiatus, A. splendens, Ceratina dupla, Odynerus foraminata, Melissodes sp., Bombus virginicus, B. americanorum, B. affinis, Psittyrus elatus, Xylocarpa virginica, Andrena carlini, Elis plumipes: Lepidoptera; Papilio philenor, Epargyreus tityrus, Pieris rapae.

Acanthaceae (Acanthus family.)

Dianthera americana.

Along the water's edge on the sand spits in Sandusky Bay, the water willow forms close communities. The corolla is two-lipped and spreading, the upper lip notched, the lower spreading and three-parted. The anthers are bi-lobed, the lobes separated and somewhat unequal, giving to the genus its name, since the separated lobes appear like two anthers on each filament. The styles lies against the upper lip, its position being marked by a

groove in the basal part of the lip. The corolla tube is short, being about 4 mm. in length, and the nectar is more accessible than in the other species under consideration. Microbembex monodonta, which was the most frequent visitor, either alighted in the lower lip thus coming in contact with the anther lobes facing inward, or alighting on the upper lip reaching the nectar by crawling down with inverted body, thus touching the anther lobes on the ends of the filaments.

VISITORS—Coleoptera; Anomala lucicola: Lepidoptera; Pieris rapae: Diptera: Syritta pipiens, Tropidia quadrata, Lucilia caesar: Hymenoptera; Microbembex monodonta, Agapostemon radiatus, Andrena sp., Megachile latimanus.

Scrophulariaceae (Figwort family.)

Minulus ringens.

This rather conspicuous blue flower is found in the marshes along the bay shores of Cedar Point. The corolla is irregular bi-labiate, with a narrow tubular throat 15 mm. in length; the upper lip bi-lobed and erect, the lower lip three-lobed and spreading, the middle lobe with a yellow platform or palate which partially guards the entrance to the corolla tube. The stamens are arranged as in Stachys. The style, which exceeds the outer stamens in length, lies between the inner pair and bears a bi-lobed plate-like stigma. No evidences of protandry or protogyny were noted, but the action of the irritable stigma renders this unnecessary, for an insect forcing its way into the flower, first comes in contact with the stigmatic lobes, and these being irritable close, preventing self-pollination.

VITISTORS—Diptera; Syritta pipiens, Allograpta obliqua, Sphaerophora cylindrica, Syrphus americana: Lepidoptera; Papilio philenor, Epargyreus tityrus: Hymenoptera; Microbembex monodonta, Agapostemon splendens, A. radiatus, Ceratina dupla, Bombus virginicus, B. americanorum, Megachile latimanus.

Verbenaceae (Vervain family.)

Verbena hastata.

This well-known herb, the "Simpler's Joy", decorates the sedge communities along the cove shore with its slender spikes of small blue flowers. The corolla tube is about 4 mm. in length, with a distinct curve so that the upper part of the tube lies horizontal, affording both nectar and pollen protection from dew and rain.

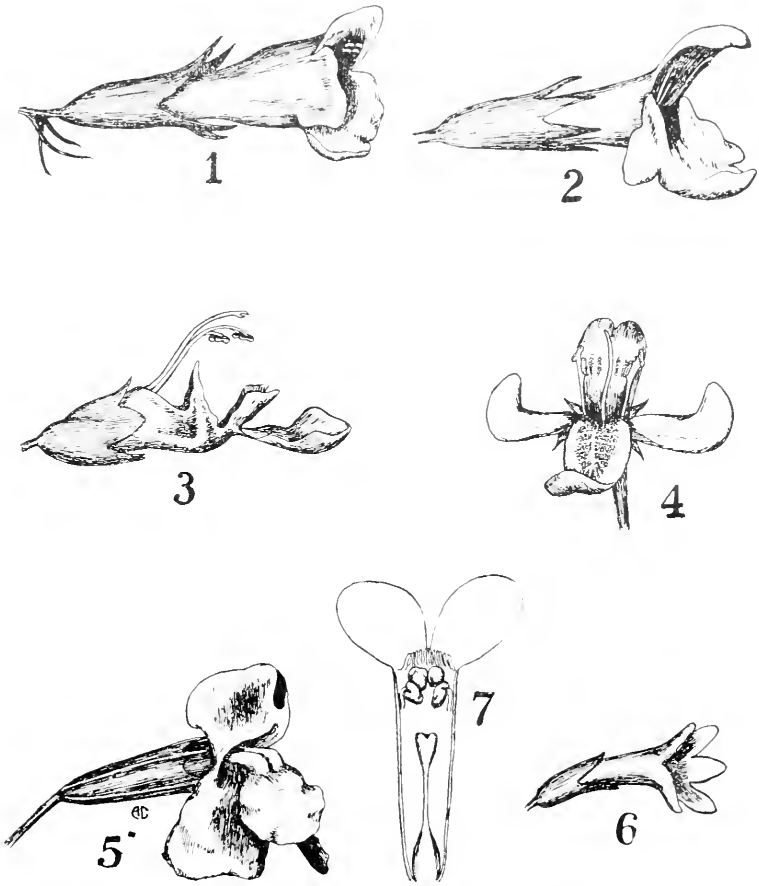
The limb of the corolla is five-lobed, the lower three lobes slightly exceeding the upper two. The throat of the slender corolla tube is closed by a ring of stiff hairs that effectually protects against . entrance of creeping forms. The stamens,

which are of two lengths, are united with the corolla tube for some distance above the stigmatic surface. As the bee's proboscis is inserted into the flower it pushes past the retrorse anthers to the nectar at the base of the tube. As the proboscis is withdrawn, in passing the anthers it bends them upward so that the dehisced surfaces, which normally lie downward and against the corolla tube, deposit pollen upon the tip of the proboscis wet with nectar. Should insect visits fail, automatic self-pollination may occur between the shorter stamens and the stigma, according to Knuth.

VISITORS—Lepidoptera: Epargyreus tityrus, Spragueia onagrus, Lycaena scudderi: Diptera; Syritta pipiens, Allograpta obliqua, Sphaerophora cylindrica, Tropidia quadrata, Helophilus latifrons, Phthiria cyanoceps; Hymenoptera; Microbembex monodonta, Agapostemon radiatus, Ceratina dupla, Odynerus foraminata, Megachile latimanus.

EXPLANATION OF PLATE XXIV.

Fig. 1. Blephilia ciliata.
Fig. 2. Stachys tenuifolia, showing relative position of anthers and stigma.
Fig. 3. Teucrium canadense, showing relation of anthers to stigma.
Fig. 4. Dianthera americana showing separated anther lobes.
Fig. 5. Mimulus ringens.
Fig. 6. Verbena hastata.
Fig. 7. Longitudinal section of V. hastata, showing ring of hairs in throat of corolla, retrorse anthers with dehiscent surfaces downward and against corolla tube.



CONGER on "Entomophilous Flowers."

KEY TO THE FRUITS OF THE GENERA OF TREES OF THE NORTHERN UNITED STATES.

JOHN H. SCHAFFNER.

The complete fruit at maturity, including the peduncle, is required for determination.

1. Fruit a cone, a cone-like catkin, a compact aggregate, or an ordinary catkin. 2.
1. Fruit simple, consisting of a single carpel or set of united carpels, not cone-like or catkin-like, but often clustered. 22.
2. Fruit dry at maturity. 3.
2. Fruit fleshy. 16.
3. Fruit a globular aggregate of flowers on a long slender peduncle. 4.
3. Fruit not globular, except in some true cones, but ovoid or cylindrical, peduncle short or if rather long then thick and rigid. 5.
4. Fruit an aggregate of dehiscent spiny-pointed capsules with several seeds **Liquidambar.**
4. Fruit an aggregate of 1-seeded nutlets, not spiny-pointed. **Platanus.**
5. Fruit a true cone with naked seeds, or an aggregate of closed carpels showing stamen, petal and sepal scars on the peduncle. 6.
5. Fruit a catkin or a cone-like catkin. 19.
6. Seeds in closed carpels, the cone-like fruit showing stamen, petal, and sepal scars at the base on the peduncle. 7.
6. Fruit a true cone with naked seeds, not showing stamen, petal, and sepal scars on the peduncle. 8.
7. Carpels of the fruit forming dehiscent follicles at maturity; the fleshy seeds suspended from the pink or rose tissues of the fruit by slender threads. **Magnolia.**
7. Carpels samara-like, dry and indehiscent. **Liriodendron.**
8. Cones with numerous ovuliferous scales, more than 15. 9.
8. Cones with 3–12 ovuliferous scales. 12.
9. Cones erect, their scales deciduous from the persistent axis; ovuliferous scales orbicular or broad, obtuse. **Abies.**
9. Cones pendulous or projecting from the branch, the scales persistent. 10.
10. Cone scales woody and thickened at the outer end, elongated, often with a rigid point, spine, or prickle. **Pinus.**
10. Cone scales sub-orbicular or oval, sometimes with erose or emarginate tips. 11.
11. Cone with subulate leaf-scales at the base. **Larix.**
11. Cone without subulate leaf-scales at the base, short and ovoid, usually less than $1\frac{1}{2}$ in. long. **Tsuga.**

11. Cone without subulate leaf-scales at the base, cylindric or long ovoid, usually 1-6 in. long, scales often with erose or emarginate tips. **Picea.**
12. Carpels spirally arranged. 13.
12. Carpels opposite. 14.
13. Cone globose, the scales closely compressed on the outside, seeds not winged. **Taxodium.**
13. Cone ovoid, with subulate leaf-scales at the base, the carpellate scales loose and open; seeds somewhat winged. **Larix.**
14. Cone oblong or ovoid; the scales not peltate, each with 2, winged seeds. **Thuja.**
14. Cone globular or spherical, the scales peltate. 15.
15. Carpellate scales with many narrowly-winged seeds. **Cupressus.**
15. Carpellate scales with 2–3 more or less winged seeds. **Chamaecyparis.**
16. Fruit globose, over 2 in. in diameter. 17.
16. Fruit elongated, ovoid or cylindrical. 18.
17. Fruit green or yellowish-green, 3–5 in. in diameter. **Toxylon.**
17. Fruit an aggregate of red drupes projecting beyond the persistent perianths. **Broussonetia.**
18. Fruit very juicy, consisting of a catkin-like aggregate of small fleshy flowers. **Morus.**
18. Fruit an aggregate of carpels, the ripe follicles dehiscent, and the seeds pendant from slender threads. **Magnolia.**
18. Fruit a small blue berry-like cone. **Juniperus.**
19. Catkin composed of capsules with numerous seeds having tufts of cottony hairs. 20.
19. Catkin containing 1-seeded nutlets, achenes, or samara-like nutlets. 21.
20. Capsule with a little cup at the base. **Populus.**
20. No cup at the base of the capsule but 1 or 2 little glands may be present. **Salix.**
21. Fruiting catkin with leaf-like bracts; nutlets with ridges, somewhat compressed. **Carpinus.**
21. Fruiting catkin hop-like, with bladder-like bracts; nutlets somewhat compressed, ridges inconspicuous. **Ostrya.**
21. Fruiting catkin woody and cone-like, nutlets small compressed, winged or wingless. **Alnus.**
21. Fruiting catkin compact with rather thin scale-like bracts, cone-like; nutlets compressed, membranous-winged; samara-like. **Betula.**

—22—

22. Fruit a dry or nearly dry samara, nut, achene, bean, or capsule, or a dry drupe. 23.
22. Fruit fleshy, indehiscent. 55.

23. Fruit or the peduncle prominently winged. 24.
23. Fruit and peduncle not with wings. 30.
24. Peduncle of the fruit cluster with a large wing; fruit a dry drupe. **Tilia.**
24. Peduncle not winged; fruit a true samara, or with 1 or more prominent wings. 25.
25. Fruit with a prominent spine-like beak at the tip and with 2 or 4 wings, large. **Mohrodendron.**
25. Fruit not with a prominent spine-like point. 26.
26. Fruit double with 2 cavities and 2 large wings. **Acer.**
26. Samara with a wing all around or with a single wing at the end. 27.
27. Samara circular, oval, or broader than long. 28.
27. Samara elongated. 29.
28. Wing extending around the fruit, very veiny, glabrous; long-peduncled, calyx not present or very inconspicuous; cavities 2, 1 usually empty. **Ptelea.**
28. Wing notched at the apex, usually veiny; fruit long-peduncled, calyx present; cavity 1 with 1 seed. **Ulmus.**
28. Wing on the two sides of the fruit, with 2 stigmas at the apex; fruit sessile, small. **Betula.**
29. Wing extending as far below the central seed as beyond it. **Ailanthus.**
29. Wing terminal or extending along the sides of the seed but not beneath it. **Fraxinus.**
30. Fruit a dehiscent bean, follicle, or capsule, usually with several seeds. 31.
30. Fruit an indehiscent nut, achene, or dry drupe with 1 cavity and 1 seed; often partly or completely enclosed in a cup or husk. 47.
31. Fruit a bean or legume with 1 cavity and 2 sutures; seeds not winged. 32.
31. Fruit a capsule; if bean-like then with 2 cavities. 35.
32. Bean an inch or more broad, mostly with pulp. 33.
32. Bean about $\frac{1}{2}$ in. broad, without pulp. 34.
33. Bean very hard and thick, seed $\frac{3}{4}$ in. long. **Gymnocladus.**
33. Bean not very woody, thin, seed less than $\frac{1}{2}$ in. long. **Gleditsia.**
34. Bean with a prominent ridge on each side of one suture, apex long-acute. **Cercis.**
34. Bean with the 2 sutures nearly alike, apex mucronate, or with a slender point, sometimes bristly. **Robinia.**
34. Bean usually irregular and somewhat constricted into joints, apex abruptly acute, calyx containing long filaments. **Cladrastis.**
35. Seed with wings or a tuft of cottony hairs. 36.

35. Seed without wings or hairs. 39.
36. Seed with a tuft of hairs, capsule small. 37.
36. Seed with wings, the wings sometimes with a fringe of long hairs. 38.
37. Capsule with a little cup at the base. **Populus.**
37. No cup at the base of the capsule but 1 or 2 little glands may be present. **Salix.**
38. Capsule very long, wings of seed with a fringe of hairs. **Catalpa.**
38. Capsule short, wing of seed without hairs. **Paulownia.**
39. Seeds very large, $1/2$–2 in. in diameter. 40.
39. Seeds much less than $1/2$ in. in diameter. 41.
40. Seed smooth with a large light spot at one end, without ridges or angles. **Aesculus.**
40. Seed with two or more vertical ridges, without a special light spot—a nut in an enclosing husk which may be mistaken for a capsule. **Hicoria.**
41. Seeds with a fleshy, scarlet aril, capsule lobed. **Euonymus.**
41. Seeds without an aril. 42.
42. Seeds 1 or 2, capsule not bladdery. 43.
42. Seeds several to many. 44.
43. Capsules small without a cup at the base. **Xanthoxylum.**
43. Capsule woody, $1/2$ in. long, with a prominent cup at the base; seeds 2, oblong. **Hamamelis.**
44. Capsule trilocular, large, bladdery. 45.
44. Capsule with 5—many cavities, small. 46.
45. Capsule 3-lobed at the tip, with 3 styles, usually widest at the middle or toward the outer end. **Staphylea.**
45. Capsule with a long, acute tip, with a single style, widest below the middle. **Koelreuteria.**
46. Capsules mostly woody, oblong, puberulent; in corymbose or umbellate clusters. **Rhododendron.**
46. Capsules depressed-globose, somewhat 5-lobed; in corymbose or umbellate clusters. **Kalmia.**
46. Capsules ovoid-pyramidal, 5-angled; in large panicled racemes. **Oxydendrum.**
47. Fruit a dry drupe, or drupe-like; exocarp softer than the bony endocarp. 48.
47. Fruit a nut or achene, the pericarp not in 2 layers; often partly or completely enclosed in a cup or husk. 49.
48. Fruit globose, $1/4$ in. or more in diameter, on winged peduncles **Tilia.**
48. Fruit obliquely ovoid, compressed, ridged on the back and covered with prominent soft processes. **Planera.**
48. Fruit subglobose, nearly symmetrical, $\frac{1}{8}$ in. long, pubescent or if not the stone striate. **Rhus.**

48. Fruit obliquely oblong or oval, compressed, gibbous, $\frac{1}{8}$ in. long, reticulate-veined. **Cotinus.**
49. Nut sharply 3-angled; usually 2 together in the 4-valved bur. **Fagus.**
49. Nut not 3-angled. 50.
50. Nut less than $\frac{1}{4}$ in. long, somewhat compressed. 51.
50. Nut large, more than $\frac{1}{2}$ in. long, or if not then circular in cross-section. 52.
51. Nut with ridges; fruiting bract 3-cleft and incised. **Carpinus.**
51. Ridges of the nutlet inconspicuous, fruiting bract bladder-like. **Ostrya.**
52. Nut with 2 or 3 prominent ridges, sometimes with rough wrinkles. 53.
52. Nut not with ridges. 54.
53. Nut rugose or sculptured; husk indehiscent. **Juglans.**
53. Nut smooth or angled, husk at length splitting into segments. **Hicoria.**
54. Nut ovoid-oblong or subglobose; cup with imbriacted, more or less united bracts. **Quercus.**
54. Nut plano-convex or rounded; bur globose and very prickly. **Castanea.**
54. Seed, which may be mistaken for a nut, not showing a style, large and shining; capsule splitting into 3 valves. **Aesculus.**

—55—

55. Fruit a pome, the carpels enclosed by an adnate, perigynous disk or hypanthium. 56.
55. Fruit a berry, or berry-like, with several seeds. 60.
55. Fruit a drupe, or drupe-like, with a stone or pit and with 1 or rarely 2 seeds. 66.
56. Ripe carpels of the pome papery or leathery. 57.
56. Ripe carpels bony. **Crataegus.**
57. Pome small and berry-like. 58.
57. Pome large, fleshy like the apple. 59.
58. Pome scarlet when ripe, cavities not more than 5. **Sorbus.**
58. Pome purplish-red to purplish-blue when ripe, cavities usually 10. **Amelanchier.**
59. Seeds not more than 3 in each cavity; pome tapering into the peduncle; flesh with grit-cells. **Pyrus.**
59. Seeds not more than 3 in each cavity; pome sunk in at both ends, its flesh without grit-cells. **Malus.**
59. Seeds many in each cavity, flesh of pome hard. **Cydonia.**
60. Berry large, very much elongated, green with yellow pulp and large brown seeds. **Asimina.**
60. Berry ovoid or globose. 61.

61. Berry about 1 in. in diameter, reddish-yellow, with 4–12 large, flat, hard seeds and with the enlarged calyx at the base. **Diospyros.**
61. Berry not over ½ in. in diameter. 62.
62. Fruit inferior, showing scars or parts of the perianth and stamens at the tip. 63.
62. Fruit superior, showing only the style at the tip, with scars or perianth parts if present at the base. 64.
63. Fruit scarlet, cavities 5. **Sorbus.**
63. Fruit purplish-red to purplish-blue, cavities usually 10. **Amelanchier.**
63. Fruit black, small, cavities 5. **Aralia.**
64. Fruit really a berry-like blue cone, showing the carpel tips on the sides, on close inspection. **Juniperus.**
64. Fruit not a modified cone, but a true berry. 65.
65. Berry-like drupe usually red or yellowish, with 4–8 bony or crustaceous nutlets. **Ilex.**
65. Berry-like drupe black, with 2–4 seed-like nutlets. **Rhamnus.**
65. Berry very saponaceous, dark; seeds 1–3, crustaceous, globose. **Sapindus.**
65. Berry black, with 1 erect, shining seed. **Bumelia.**
66. Fruit large, usually 2 in. or more in diameter; stone or nut deeply pitted, corrugated, or sculptured, usually 1½ in. or more long. 67.
66. Stone not deeply pitted, corrugated, or sculptured, not more than ¾ in. long; if reticulated, then less than ½ in. long. 68.
67. Flesh of fruit black or greenish, hard, with strong odor; seed in the nut much wrinkled. **Juglans.**
67. Drupe pubescent, its flesh sweet; seed in the stone smooth. **Amygdalus.**
68. Drupe white-waxy, less than ¼ in. in diameter, globose, tuberculate. **Myrica.**
68. Drupe not white-waxy, if somewhat resinous then much larger. 69.
69. Fruit superior, showing only a style or its scar at the tip but usually the remains of a calyx below. 70.
69. Fruit inferior, showing sepals, petals, and stamens or their remains or scars at the tip. 75.
70. Drupe small, with red acid hairs, or if gray then the stone striated. **Rhus.**
70. Drupe not with red acid hairs nor gray with striated stone. 71.
71. Drupe narrowly oblong, about 1 in. long. **Adelia.**
71. Drupe globose, oval, or globose-oblong. 72.
72. Stone ridged and reticulated, showing prominent teeth in cross-section. **Celtis.**

72. Stone, smooth, or if somewhat roughened then with a prominent suture all around. 73.
73. Fruiting pedicel much thickened below the prominent calyx base, red; drupe oblong-globose, blue. **Sassafras.**
73. Fruiting pedicel not thickened below the calyx or if so the fruit not blue. 74.
74. Fruit light greenish-yellow; flesh with a sickening-sweet odor and a sticky juice; embryo in a large kernel; a gymnospermous seed. **Ginkgo.**
74. Drupe often large and sweet, stone with a suture all around, often flattened. **Prunus.**
74. Drupe with a 4–6 lobed calyx; oblong-ovate, blue; endosperm large with a small embryo in the center. **Chionanthus.**
74. Fruit really a small black berry; seed shining, with the hilum at the base. **Bumelia.**
75. Stone with 2 cavities and 2 seeds, calyx 4-toothed; drupe with stylar beak, red, white, or blue. **Cornus.**
75. Stone with 1 cavity and 1 seed, grooved and somewhat compressed; drupe glabrous, blue or nearly black. **Nyssa.**
75. Fruit with prominent nerves and ridges, with 5 sepal-tips, oblong-ovate, pubescent, nearly dry, nut-like. **Symplocos.**
75. Stone 1-seeded, sometimes flattened; drupe with a prominent stylar beak, blue, black, or red. **Viburnum.**

MEETING OF BIOLOGICAL CLUB.

Orton Hall, Dec. 4, 1911.

The meeting was called to order by the President, W. M. Barrows. The minutes were read and approved. The Club then had the pleasure of listening to an interesting lecture by Prof. Herbert Osborn on "Some Collecting Trips in Western States." The trips of which Prof. Osborn spoke carried him through about forty states and territories. Their principal object was the study and collection of Jassidae affecting various forage crops. Certain of these insects were found to be strikingly adapted to conditions which must have prevailed for a long period of years. The talk was illustrated with a number of excellent lantern slides and was followed by an interesting discussion.

The meeting closed after a short business session in which Messrs. Schlopp, Mote, Busby and Bilsing were elected to membership.

C. L. Metcalf, Secretary.

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TABLE OF CONTENTS.

FIVE NEW SPECIES OF NORTH AMERICAN TABANIDÆ.

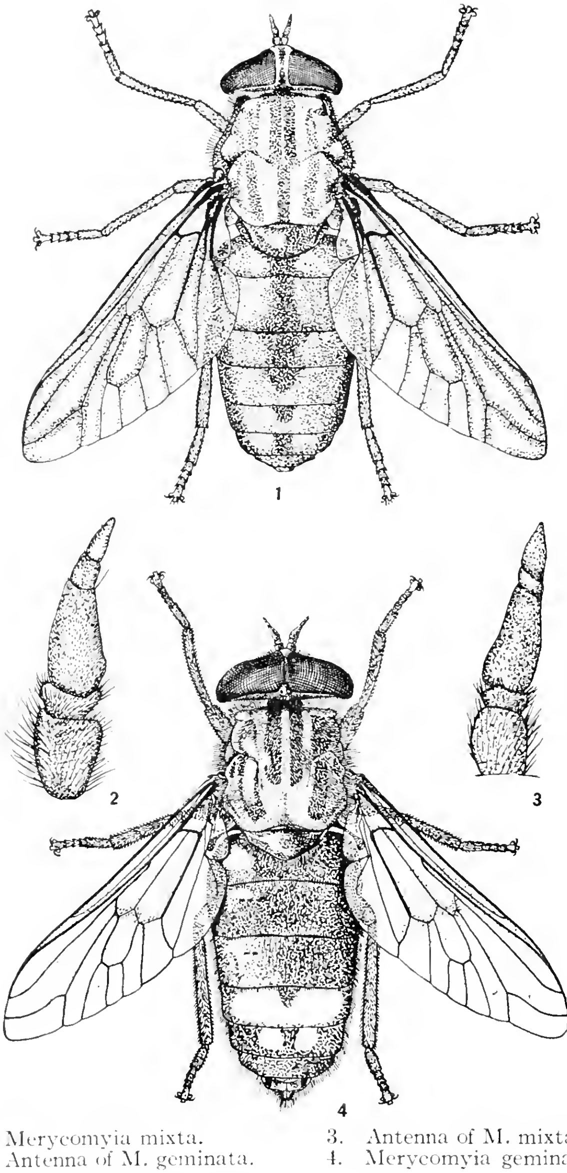
JAS. S. HINE.

Tabanus floridensis n. sp.

Female, length 10 millimeters. Size and general appearance similar to T. pumilus from which it differs by the distinctly wider front. Frontal collosity transverse, as wide as the front, shining black and with a small denuded marking above it. Antenna narrow, distinctly narrower than in pumilus, first and second segments pale with black hairs above, third segment nearly black; face clothed with long white hair, palpi narrow, pointed, and clothed with short white hair, proboscis dark, eyes naked. Thorax dark gray above with lighter stripes, wings hyaline, furcation of the third vein without a fork, legs dark reddish. Abdomen dark colored, hind margins of the segments, a series of more or less plainly marked middorsal triangles and a row of rather large spots on either side gray.

Type female from Fort Meade, Florida, April 4, 1909. Twelve other females taken at different places in southern Florida in April.

Although the species suggests pumilus it is entirely distinct. The front is much wider, the antennæ are narrower, the legs are colored differently and the gray spots on either side of the abdomen are larger. It is distinct from sparus and fratellus also, as will be found by comparing these same characters.



1. Merycomyia mixta.
2. Antenna of M. geminata.
3. Antenna of M. mixta.
4. Merycomyia geminata.

HINE on "North American Tabanidae.

Tabanus fulvistriatus n. sp.

Female, length 8 millimeters. Antennæ yellow, sides of the front nearly parallel, frontal callosity shining black, prominent, occupying the entire width of the front and with a raised line connects with the upper side. A denuded spot at vertex but no ocelli present. Thorax brown without stripes, wings dilute brownish; legs largely yellow, front femora brown, apial half of front tibiæ and entire tarsi black, other legs with each tibia narrowly brown at apex and each tarsus almost wholly black beyond the apex of the metatarsus. Abdomen brown in ground color, a wide middorsal stripe and lateral and hind margins of the segments pale yellow; venter pale at base, darkened toward the apex.

The type female and one other specimen taken at Dona Maria, Chiapas, Mexico, by D. L. Crawford.

This fly shows some resemblance to Tabanus unistriatus of Costa Rica and appears to be related to T. maculifrons of Guatemala. The small size, together with the wide middorsal abdominal stripe easily designates the species however.

Merycomyia n. gen.

Closely resembling Tabanus, but distinct on account of the presence of well developed ocelli in both sexes and the anomalous antennæ which show only three annulations in the third segment instead of five, although this last character shows some tendency to vary. Eyes naked, no spurs at the apex of the hind tibia, wing venation as in Tabanus, anal cell closed and petiolate. No stump on the anterior branch of the third vein. Type species Merycomyia geminata.

There are in my collection three specimens of two distinct species of this genus. I have held these specimens a long time and have compared many descriptions without finding anything that suited, hence the conclusion to refer them to a new genus.

Merycomyia geminata n. sp.

Male, length 21 millimeters. A dark colored species with pale brownish wings. Third segment of the antenna largely reddish, proboscis short and dark colored, eyes contiguous, ocelli prominent. Thorax dark colored with the usual gray stripes, all the femora dark reddish, tibiæ darker, tarsi black; wings brownish gray with the veins in the anterior part quite plainly margined with brown. Abdomen nearly black, slightly reddish on the sides, fourth segment with a large transverse gray patch which is plainly indented anteriorly on the middorsal line by a black triangle, fifth segment with two small gray spots.

Female much like the male but more reddish in ground color, eyes widely separated, front slightly widest below with a rather extensive denuded patch but no distinct frontal callosity. Total length slightly less than the male measurement.

The type male from which the accompanying drawing was made, was taken at Lyme, Ct., by B. H. Walden, and sent in by Dr. W. E. Britton. The female was procured at Wheatlands, Indiana, by Harold Morrison.

The widely separated localities at which the specimens were taken indicates that the species has an extensive distribution. There does not appear to be the least doubt but that the two specimens in my possesion are sexes of the same species.

Merycomyia Mixta n. sp.

Female, length 21 millimeters. General color reddish brown. Eyes widely separated, front slightly widest below with an elongate denuded patch which narrows to a point above. Ocelli conspicuous. Thorax gray with darkened stripes above; wings wholly brown anteriorly, veins widely margined with the same color posteriorly, legs brown. Abdomen reddish brown with the lateral margins and a middorsal marking nearly black, venter rather dark.

The type female from which the accompanying drawing was taken was procured at Bainbridge, Georgia, by J. C. Bradley, June 2, 1911.

Stibosoma flavistigma n. sp.

Female, length 17 millimeters. A black species with apex of the wings hyaline and a yellow marking including the stigma and reaching from the costa to the opposite side of the discal cell.

Front and face black, antenna with the basal process of the third segment much produced. Thorax black, legs with all the tibiæ somewhat swollen, wing black, except the apex is hyaline and a patch in the region of and including the stigma is yellow; knob of the halteres green. Abdomen black, narrow margins of all of the segments, both dorsally and ventrally, gray.

Type female, taken in Vera Cruz, Mexico, by D. L. Crawford.

A PRELIMINARY REPORT ON A PHYSIOGRAPHIC STUDY OF BUCKEYE LAKE AND VICINITY.

FREDA DETMERS.

For the past three years, beginning with the spring of 1909, I have been engaged in a study of the plant geography of Buckeye Lake. An understanding of the physiography and of the physiographic history of any region is essential to a comprehension of the development of the flora of that region; therefore as the physiographic study is so closely correlated with the botanical, the two were carried on at the same time.

A careful inspection of the topography, and an examination of the literature on the physiography of Buckeye Lake and its vicinity soon developed three topics of especial interest. These were: I, the existence or nonexistence of Lake Licking, a post or interglacial lake occupying the plains to the south and southwest of Newark, including Buckeye Lake; II, the physiographic history of Buckeye Lake and III, the location and extent of the Newark river valley, a preglacial valley, from Newark westward to the Franklin county line.

These three problems are discussed in this paper in the same order as presented above.

I. The existence or nonexistence of Lake Licking, a large post glacial lake south and southwest of Newark.

In the report on the geological survey of Licking county, by M. C. Read,[1] the statement is made that to the south and southwest of Newark a lake of considerable size covered the surface "in the latter part of the glacial epoch." The statement gives opportunity for a very wide interpretation as to the possible or probable age of this lake and it makes no reference at all to its longevity. As the region in question is covered by the Illinoian, the early and the late Wisconsin drift-sheets,[2, 3] the lake may have been post glacial, that is: formed by the recession of the Late Wisconsin ice, or interglacial and formed by the advance or retreat of the Early Wisconsin or retreat of the Illinoian and still fall within the "latter part" of the entire glacial epoch.

In another paragraph of the same report Mr. Read[4] says: "The larger channels are now filled with water-washed pebbles resting ordinarily upon the old rocky bed, but in places upon the remains of the original drift clay, by a succession of terraces and corresponding water plains. South and southwest of Newark these water plains expand covering a large area." From this

1. Read M. C. Geology of Licking County, O. Geol. Survey **3**: 348–361, 1878.
2. Leverett, Frank. Mon. 41: U. S. G. S.
3. Chamberlain, T. C., and Salisbury, R. D. Geology. Earth History. **2**: **3**: 1906.
4. Read M. C. Geology of Licking County, O. Geol. Survey **3**: 1878.

statement I infer that the "water plains", according to Mr. Read form the present surface of the region and were the bed of the former lake, presumably post-Wisconsin, which must have existed until very recent times; and that the present and recently drained swamps of this region were remnants of the lake.

In June, 1894, W. G. Tight[5] published an article in which several pages are devoted to the topography and present drainage of Licking county. In this article he says: "The South Fork of the Licking flows with a sluggish current over a broad alluvial plain which is covered with a black lacustrine deposit of several feet in thickness. This is especially true of that portion lying between the Licking Reservoir and Newark. We have suggested the name Lake Licking for the body of water in which these deposits were made and of which the original lake in the Reservoir was a part, occupying a large kettle hole in the drift when the main body of water was drained away."

The above statement by Mr, Tight definitely refers Lake Licking to post Wisconsin times; as these "lacustrine deposits" and Licking Reservoir, the present Buckeye Lake, are at the surface and must therefore lie on the drift.

Black alluvial deposits indicate river beds or swamps rather than lakes. Moreover black soil does not prevail throughout this area, but is seen only in depressions, which have evidently been shallow kettles.

The region to the south and southwest of Newark is characterized by a mature topography, as an inspection of the country or a study of the topographic sheets of the Thurston, Thornville, Granville and Newark quadrangles clearly show. The hills are low and rounded, with gentle slopes; the streams flow in broad open valleys, which together with the hills are deeply covered with a drift mantle to a maximum depth of 453 feet. The valleys are so deeply filled that the present highest elevations are but 200–214 feet above the valley floors. This extensive leveling up has converted the low lands into a region with the topography of youth, characterized by low watersheds separated by broad plains and drained by numerous small, shallow, irregular streams, many of which are wet weather streams only; and also by numerous surface depressions varying in size from small kettles a few square yards in extent to swamps covering several hundred acres.

There is no well-defined either rock or morainal ridge of hills which could serve as the rim of a large lake. The surface cover, except in the kettles and beds of streams is unassorted glacial till, consisting of clay containing many small sharp angled stones, and with a srtiking absence of large boulders. I can nowhere find lake beaches, lake clays, sand or stream delta deposits. Glacial

5. Tight, W. G. A contribution to the knowledge of the preglacial drainage of Ohio. Bull. Den. Univ. **8**: 1. 38. 1894.

till devoid of boulders and composed largely of clay is easily transported by streams and readily lends itself to delta formation. This is well shown by the relatively extensive deltas built by several small streams flowing into Buckeye Lake. One of these called the Southwest Feeder, a distributary from the Licking River, near Kirkersville, flows across the plain in a southerly direction and enters Buckeye Lake just north of Millersport. The Feeder dates from the completion of the Reservoir in 1832 and is therefore 80 years old. In this time it built a delta approximately 200 feet long. A dense mat of pond plants has so blocked the outlet that but little water is received by the lake from this source during periods of ordinarily dry weather.

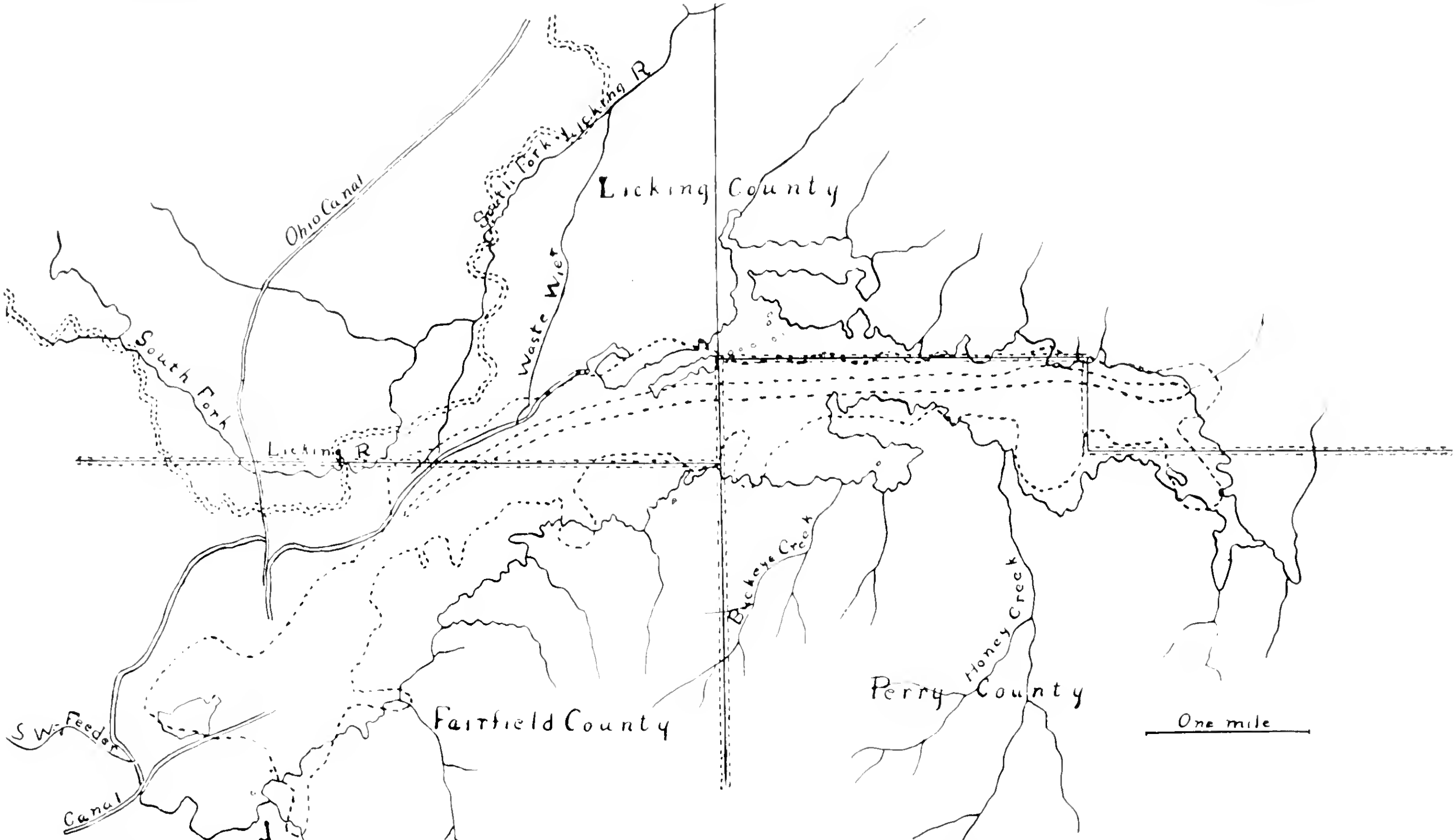
The mouth of Buckeye creek, one of the largest tributaries to Buckeye Lake from the south, is so shallow and so choked with aquatic and marsh plants that it is obliterated during the summer months. The same condition would prevail at Honey creek, another tributary from the south, if the channel were not dredged and thus kept open.

Streams dating from the recession of the Wisconsin ice must have built deltas so extensive, that they would be readily recognizable. Moreover, there cannot have been an extensive post Wisconsin lake of long duration if we accept Mr. Mather's[6] conclusion as to the age of the gorge of the Licking River at the Licking Narrows. From his study of this gorge Mr. Mather concludes that it antedates the Wicsonsin ice age. If this can be accepted, a post Wisconsin lake would have been drained by the eastward flowing Licking River, for this outlet is broad and deep enough to have prevented the retention of a large body of water to the west at the fort of the glacier.

It seems to me that all the positive and negative evidence which the region affords precludes the possibility of the existence of a large post Wisconsin lake or anything more than a temporary and shallow body of water which would naturally result from the melting of an extensive ice sheet.

What is the evidence for or against the existence of a large interglacial lake in the region under discussion? Such a lake if formed by the recession of the Illinoian ice sheet, must have extended 20 miles from north to south and 20 or more miles from east to west and with its bed at least as deeply excavated as the streams which entered it. The record of a gas well in the Raccoon creek valley, just before it suddenly widens to join the broad plain west of Newark and $\frac{3}{8}$ of a mile north of the crossing of the creek by the Ohio Electric railway, shows that the rock has been excavated to a depth of 453 feet below the present surface. This well marks the greatest depth in an old valley whose stream would have been

6. Mather, K. F. Age of Licking Narrows. Bull. Den. Univ. **14**: 174–187. 1908, '09.



Map of the "Big Swamp" of the survey of 1799, superposed on that of the survey of 1909 by the Civil Engineering Department of the Ohio State University; survey of 1799 represented by broken lines, that of 1909 by unbroken lines.

a tributary to this lake. Moreover this lake if not with a larger oulet than inflow of water must have existed for a long span of time and would have left unmistakable evidence of its presence in lake beaches, sands and clay deposited on its floor and deltas at the mouths of its tributaries.

All the records of gas wells in this region, from which I was able to obtain details, show a thin mantle, in some wells but 8–10 feet thick, of glacial clay overlying a heavy bed of gravel. In one such well close to the Baltimore and Ohio railroad tracks and 1¼ miles north of the lake the gravel is but 2 feet below the surface and is 100 feet thick. In another well in the field west of the Ohio Electric railway and but a few rods from the north shore of the lake, there was, according to the foreman's notes, 10 feet of loam and 350 feet of sand and gravel. All the water wells near Buckeye Lake are in the gravel. In one at the Glass Hotel on the north shore, sand was entered at 10 feet below the surface, and the well is in gravel at 75 feet. In some of these wells sand lies above the gravel and in others beneath it. This thick stratum of gravel was not deposited in the quiet waters of a lake. So massive a load can only have been carried by the flood waters from a glacier. The gravel is evidently an outwash deposit.

II. The physiographic history of Buckeye Lake.

Buckeye Lake is situated in Licking, Fairfield and Perry counties, in Ranges 17 and 18, Townships 17, 18 and 19. It is a long irregular body of water with its longest diameter from east to west. It is approximately 7⅛ miles long from the southeastern most extremity to the western and varies in width from ¼ mile in the eastern portion to 1½ miles at the extreme western end. The area covered is estimated at 4,200 acres. The lake is quite shallow; the water over large areas does not exceed a depth of 6–8 feet at the normal water level; but there are a few deeper depressions. Soundings just off the south shore of Cranberry island revealed a depth of 15 feet, and near Avondale a depth of 25 feet, which Mr. Bootin, the engineer of the Canal Commission assures me is the greatest depth he has found.

This basin was built in 1832 to serve as a reservoir for the Ohio canal. On May 21, 1894, the General Assembly of Ohio passed an act reserving it for a public park and summer resort to be known as Buckeye Lake.

The site of the reservoir was a more or less completely tree-covered impassable swamp, known to the Indians and early settlers as the "Big Swamp," "Two Lakes" or "Big and Little Lake."[7] It lay diagonally across the southeast corner of Township 17 and almost half across the southern border of Township 19. In shape and area it approximated the present lake. In the

7. Graham, A. A. History of Licking County, O. Chap. XVII, p. 165. 1881.

center of the swamp was, according to the surveys of 1799 and 1801, a long narrow lake fed by several small streams. This lake drained into the South Fork of the Licking River near the "Black Diamond," 1/2 mile southwest of the present Waste Weir.

The location seemed well suited for a reservoir. It was a quite extensive natural basin, lying on a plain, with a rim of hills to the south, east and northeast immediately bordering the swamp; so that no levee would be necessary along these margins. To the north and west of the present lake are low fields which very likely were wholly or at least in part included in the original swamp. The swamp drained towards the north, the lowest place in the rim is indicated on the topographic map of the U. S. G. S. by a small stream, which apparently unites Buckeye Lake with the South Fork of the Licking River. This outlet, however, no longer exists.

The so-called "Old Reservoir" was begun on the morning of July 4, 1825, and was finished in 1828. The swamp was not deepened nor even cleared of trees. A levee, with a maximum height of 18 feet at the "Black Diamond" and decreasing somewhat to the east and west, was built along the north side from the present "Park" to the western extremity and was continued around the west end. This latter served as the tow-path of the canal.

The "old reservoir" did not furnish the canal with sufficient water to permit the carrying of even half a load during the drier summer months, therefore an additional 500 acres on the west were added in 1832. This addition was called the "new reservoir." An additional supply of water was also provided by a distributary from the Licking River, which taps the river just north of Kirkersville and enters the reservoir 1/8 of a mile north of the western exit of the canal.

The old swamp lay in the preglacial valley of a tributary of the Newark valley, a valley now occupied in part by the west fork of Jonathan creek. Just east of Thornville station the tracks of the Newark and Shawnee Branch of the Baltimore and Ohio railroad, which parallel the east shore of the lake, and the Zanesville and Western railroad from the south meet in a cut or gap and continue eastward as parallel tracks. The floor of this gap is but little broader than the width of the two tracks.

A loop moraine was formed in Late Wisconsin time across the valley at this point and completely blocked the then westward flowing stream. The lower or westward portion of the valley was still filled with ice. As the ice receded, the water ponded behind the moraine broke through forming the gap now occupied by the railroad tracks, and flowed eastward down the valley. This overflow gap is very distinct and was first referred to by G. F. Wright,[8]

8. Wright, G. F. The glacial boundary in Ohio, Ind., and Ky. 1884.

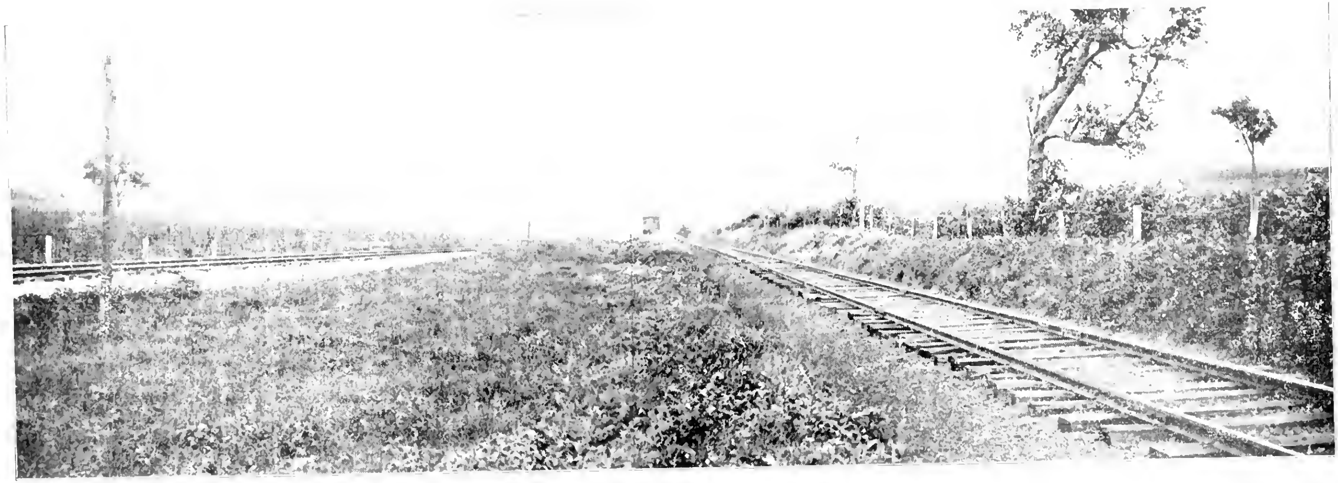
who says: "The reservoir occupies a great kettle-hole. the railroad which here cuts through the moraine follows for several miles towards the southeast an outlet for the glacial floods."

The overflow channel is 900 feet above sea level, whereas the surface of the present lake is 892 feet. This eastern outlet could drain the lake only when the water surface exceeded the 900 foot level. During the time when the water stood at or slightly above the 900 foot level, the area covered was much greater than the present one. The broad plain to the north between the present lake and Newark is less than 900 feet, with small irregular isolated areas from 900 to 960 feet above sea level. It is 10 miles from north to south. At the southern limits of Newark it is 3 miles from east to west and 10 miles from east to west at the northern margin of Buckeye Lake. When therefore the ice receded from this plain the latter was covered by a body of water measuring 10 miles rom north to south by 10 miles from east to west at the southern and 3 miles at the northern end. This lake, if lake it can be called, stood at or above the 900 foot level for so short an interval that careful search has disclosed no beaches, deltas, lake sands or clays. The soil in the fields south of Thornville station at the 920 foot contour line, contains some fine sand, it is fine grained sandy loam; and there is also sand in the banks of a small stream which flows north and enters the southwestern lobe of the lake at Thornville station. There is however so little sand that it certainly does not form a well defined beach.

The water must have very soon drained away to the northeast and must have been in the nature of a broad river, rather than a lake over the plain southwest of Newark.

The recession of the ice from this plain uncovered an outlet lower than the 900 foot level and the southeastern one at Thornville station was abandoned. This new outlet was not deep enough nor w th sufficient fall to completely drain the basin; for a long, narrow, irregular, typical finger lake, conforming in shape to the old river valley remained in the western portion of the preglacial valley of Jonathan creek. All of this lake but a narrow channel near the center had been reduced to a swamp by the close of the 18th century.

That this swamp, which was known as the "Big Swamp," dates from early post-Wisconsin time is shown by the presence of a cranberry-sphagnum bog which still exists in Buckeye Lake. This bog, locally known as the Cranberry marsh, lies in the eastern part of the lake, close to and parallel with the north shore. It is 3,250 feet from northeast to southwest by 750 feet from northwest to southeast, and has an approximate area of 45 acres, according to the survey made in the winter of 1910 by Professor Chamberlain of the Civil Engineering Department of the Ohio State University.



View of overflow channel just east of Thornville station.

The outline is very irregular due to many indentations and small fringing islands, and changes from year to year. This is due to the frequent and extreme changes in water level in the lake. For four years within my knowledge, the water was lowered every summer, over 6 feet in 1909, so that repairs might be made. The storm winds of winter every year detach fragments of the island and sweep them away.

The vegetation is of peculiar interest; for it consists of typical bog plants characteristic today of high temperate latitudes and generally accepted to be relicts of early post-glacial times, stranded and persisting and now surrounded by the normal vegetation of the present climatic conditions.

The typical bog plants are several species of Sphagnum, the Cranberry (Oxycoccus macrocarpus), the Sundew (Drosera rotundifolia), several species of bog sedges as Carex limosa and C. filiformis, the Buckbean (Menyanthes triloba) and Scheuchzeria palustris forming a bog-meadow bordered by a zone of bog-shrubs of which the Poison Sumac (Rhus vernix) the Black Alder (Ilex verticillata) and the Choke Berry (Aronia arbutifolia and A nigra) are the most characteristic

Soundings in the bog revealed the presence of a sandy shell marl, a lake deposit, at a depth of 28 feet. The marl was still foun in some places at the 18 foot level giving a depth of 10 feet of shell marl. The presence of marl may be taken as an indication of Characeae or Cyanophyceae. Immediately above the marl was a dark brown or black plastic deposit with fragments of Potamogeton and Scirpus lacustris. These are pond plants growing in water not deeper than 5½ to 6 feet. In another sounding the core from the 22 foot level showed a fine gradation between the marl and the pond deposit. At 15 feet the core showed a preponderance of sedge material, which indicates water at less than 5 feet. At 7 feet the core contained Sphagnum mixed with the sedge remains. At 5 feet the peat was loosely matted, coarsely fibrous but little modified Sphagnum fragments with roots and stems of cranberry and other plants. Large water pockets were encountered near the surface and even at a depth of 17 feet. At the bottom of this series containing evidence of lake and pond deposits is a fine grained blue clay. The blue clay varied from the 28 to the 40 foot level. Soundings deeper than 40 feet could not be taken as that was the maximum length of the sounding rod. This fine grained blue clay belongs I believe to the Illinoian drift.

The records of these soundings sketch the history of the island. At the northern margin of the ancient lake species of Potamogeton and other aquatics formed a more or less dense mat. The water gradually became more shallow through the accumulation of silt and plant remains; and the aquatics were succeeded by semi-

View of Cranberry Island from the west.

aquatic plants with fixed roots and submerged or floating leaves. Such plants as the pond lilies and lotus with large leaves and rhizomes add rapidly to the vegetal deposit and prepare the soil for sedges and other marsh plants which grow in quite shallow water. Sedges are well adapted to holding and adding to the soil and adding to the mat. Thus a sedge meadow was formed. The sedge mat in turn was succeeded by a sphagnum-cranberry bog. In such a mat the circulation of the water becomes impeded, gases set free in processes of decomposition collect and the mat is buoyed up so that it remains at or near the surface of the water. As the mat increased in thickness the surface finally rose above the water, became better aerated and the soil was prepared for shrubs and finally trees. The older portion of the bog was of course on the landward side. As the changes sketched were taking place in the bog it was constantly spreading out farther into the lake.

When thru the conversion of the swamp into the reservoir, the water level rose rapidly, all the fixed plants were submerged and killed but the floating mat of the cranberry-sphagnum bog was buoyed up on the surface and escaped extermination. Cut off from the shore by the water it became an island.

The presence of this bog presents conclusive evidence that the body of water in which it developed dates from the close of the glacial epoch.

The map of the survey of 1801 contains a number of smaller swamps to the west and northwest of the "Big Swamp." All of them have been drained and are either wood lots or are under cultivation. They vary in size from mere depressions in cultivated fields and meadows to 400 acres in area. Of these swamps the largest, known as "Bloody Run" or "Pigeon Roost" swamp, is 2 miles east of Kirkersville and ½ mile south of the Ohio Electric railway. It is now almost wholly under cultivation, but 13 years ago it was a bog forest of soft maple, swamp ash and white elm with an undergrowth of willow and poison sumac. A drove well on one of the farms shows 17 feet of peat, then 3 feet of yellow clay, below this hard pan covering the gravel from which comes the water supply. These smaller swamps all lie at a lower elevation than the 900 foot level and as even the largest has a substratum of glacial clay they must have occupied depressions which were due to the inequalities of deposition.

III. The location and extent of the Newark river valley from Newark westward to the Franklin county line.

Frequent reference has been made to the existence of a broad and deep pre-glacial valley extending from Hanover westward to the Scioto Basin. Mr. M. C. Read was, I believe, the first to mention this valley. In the Report of the Geology of Licking county[9] Mr. Read writing of this pre-glacial channel says: "A

9. Read, M. C. Geology of Licking County, O. Geol. Survey 3: 348, 1878.

deep pre-glacial channel from the north enters the county a little west of the Sandusky Branch of the Baltimore and Ohio Railroad, extending southward to Newark and is now occupied by the northern branch of the Licking River. At Newark it divides, one branch turning directly to the east in the valley of Licking River, and one branch extending *northwesterly, through what was evidently at one period a broad lake, and in which now the south branch of the Licking flows with a reversed current to join the main stream at Newark."

The presence of this old valley has been corroborated by W. G. Tight[10] and Frank Leverett.[11]

Mr. Leverett[12] sketches the position and extent of the old valley in the following paragraphs:

"Tight has shown that the greater part of the Muskingum drainage system was formerly connected with the Scioto system by a broad valley leading from Dresden (a few miles above Zanesville) westward past Newark to the Licking reservoir and thence into the Scioto Basin near Circleville. The present southward course past Zanesville is there a much narrower valley than the old line leading westward to the Scioto Basin, and the rock floor is markedly higher along the present course of the Muskingum than along the old course.

"At Hanover, an open valley sets in which extends westward to the vicinity of the Licking reservoir, where it is so filled with drift as to render its further course difficult to determine. A series of gas borings however, indicate that it passes southward about to Hadley Junction and then turns westward, passing near Canal Winchester and Groveport and coming to the Scioto River about midway between Columbus and Circleville, where it seems to have joined the old Kanawha system."

I have quoted Mr. Leverett at length, for his location of the valley is in the main verified by the data I have been able to secure.

The mantle of drift throughout this region is so thick that the beds in the streams lie in it, neither railroad cuts nor water wells cut through to the rock. The only data therefore which give the entire depth of drift must be obtained from gas wells, which fortunately are very numerous in this section. I obtained records from a large number of wells from Newark southwestward to a point on the Little Walnut about 2½ miles east of Lockville.

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*Northwesterly must be an error. The South Fork of the Licking flows from the southwest to the northeast across the plain, west and southwest of Newark. Northwesterly should undoubtedly read southwesterly.

10. Tight, W. G. Drainage modifications in southeastern Ohio and adjacent parts of W. Va. and Ky. U. S. G. S. Prof. Paper, 13.

11. Leverett, Frank. Glacial formations and drainage features of the Erie and Ohio Basins. Mon. 41: U. S. G. S. 155, 1902.

12. Leverett, Frank. Glacial formations and drainage features of the Erie and Ohio Basins. Mon. 41: U. S. G. S. p. 155, 1902.

From these logs the direction, location, depth and in many places width of Newark valley can be plotted quite accurately.

Beginning with the southwestern portion of Newark, a well just north of the junction of the South Fork of the Licking and Raccoon creek and half way between the union of these streams and the tracks of the Shawnee Branch of the Baltimore and Ohio railroad shows that the rock has been excavated to 527 feet above sea level, 323 feet below the present river at that point. From this point southwestern for a distance of 5 miles the center of the old valley lies a little to the west of the Ohio canal and the Ohio Electric railway. It then turns directly south to Buckeye Lake. A well $2\frac{1}{2}$ miles northeast of Hebron shows the rock to have been excavated to 510 feet above sea level, which is 360 feet below the present surface. Here the width of the ancient valley is clearly shown by well defined valley walls. To the west just north of Luray on the National road the rock walls are 930 feet above sea level; but 30 feet below the present surface; and to the east a well $\frac{2}{3}$ of a mile north of the National road and 300 feet east of the Baltimore and Ohio railroad tracks struck the rock at 920 feet above sea level, but 40 feet below the present surface.

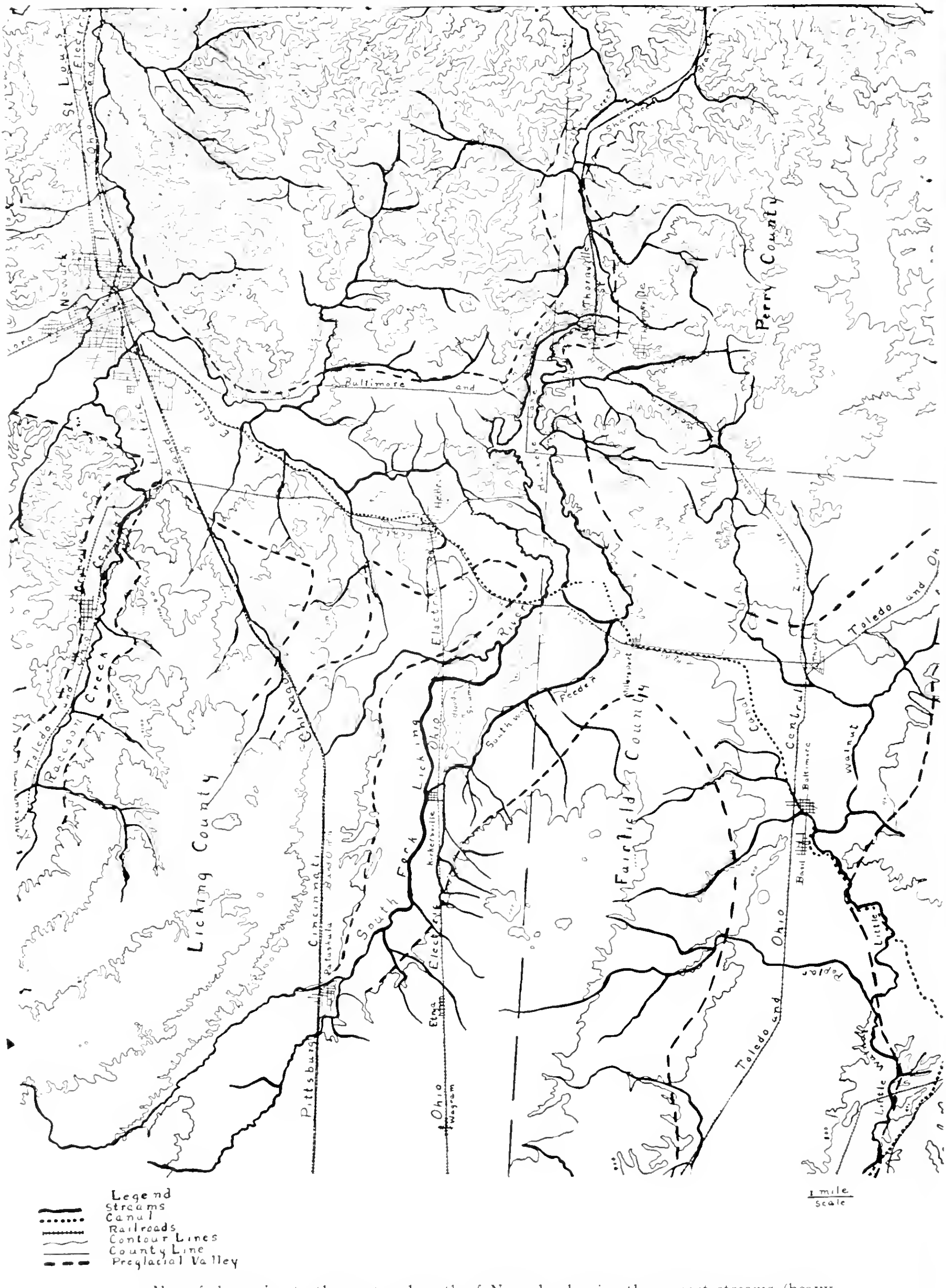
Measuring from these points I find the valley to have been $4\frac{3}{4}$ miles wide along the National road. The greatest depth in this area was found in a well in the field along the north shore of Buckeye Lake. Bed rock in this well was struck at 430 feet below the present surface, 450 feet above sea level. Buckeye Lake lies along the southern margin of the valley and not in the center. The trend from the lake is south and southwest to Basil and Baltimore. Between the lake and Baltimore I found but few wells so that the valley is not so clearly defined in this section, but it is much broader than immediately north of the lake.

Gas wells are very numerous at Basil, Baltimore and in the immediate vicinity of the two towns. Here the valley is at least 8 miles wide, is open and level. At Basil it turns more directly to the southwest following in general the course of the Little Walnut. It crosses the Franklin county line and connects with the valley mapped by Dr. Hubbard[13] in Franklin county. Newark valley as I have traced it coincides quite closely with the one described by Tight[14] and Leverett[15] except in the southern portion. Among the well records of this section the greatest depth is recorded in a well in Basil, which shows that the rock has been excavated to 452 feet above sea level, 388 feet below the level of Little Walnut creek. If this greatest depth was approximately the center of the valley the stream was here farther north than the one mapped by Tight.

13. Hubbard, George D. The Geology of Columbus and vicinity. Bull. 14: Geol. Survey of Ohio. 1912.

14. Tight, G. W. Drainage modifications in southeastern Ohio and adjacent parts of West Virginia and Kentucky. U. S. G. S. Prof. Paper 13.

15. Leverett Frank. Mon. 41: U. S. G. S. p. 410.



Map of the region to the west and south of Newark, showing the present streams (heavy unbroken lines), and the preglacial Newark valley (broken lines), from Newark southwest to the Franklin county line. The largest preglacial tributaries are also shown. The light unbroken lines are the one hundred foot contours.

Newark valley had several large pre-glacial tributary valleys. There is one from the northwest and now occupied by Raccoon creek, which near its mouth must have been of the nature of a gorge, bordered on either side by rock hills 3/4 of a mile apart; and now covered by a thin drift mantle. Two well records in the center of the valley at the mouth or point where the pre-glacial tributary joined the Newark valley show that bed rock has been excavated to 436 and 427 feet above sea level, 444 and 453 feet respectively below the present surface level. The valley of the tributary broadens abruptly from this point into that of the Newark river. Farther south is a tributary from the northwest. This valley is now occupied by the South Fork of the Licking river. It trends almost due east, then turns abruptly to the southeast and must have entered the Newark valley near the Bloody Run Swamp, where it suddenly widens. From the east Newark valley received a large branch which is now occupied in part by the eastern portion of Buckeye Lake and in part by the western portion of the now eastward flowing Jonathan creek. It is very evident from an inspection of the region and a study of the topographic maps of the Thornville and Zanesville quadrangles, that Jonathan creek is a composite stream.[16] That part of the creek west of its union with Turkey Run flows in a larger, more open and older valley than that immediately to the east of this point. In the eastern portion to within a mile of Fultonham the stream flows in a narrow gorge like valley between rock hills. Turkey Run, a tributary from the south, flows northwest, which is almost at right angles to the course of Jonathan creek, then near its outlet makes a decided curve, turning north and then east, following closely the base of the hills, before it joins the larger stream. The valley of the headwaters of Jonathan creek broadens toward the west. A mile east of Thornville station it is 2 miles wide. Valley Run, its largest tributary from the north, also occupies a valley out of proportion to the size of the present stream. Moreover it comes in from the northeast and joins Jonathan creek headed or pointed up stream. These data seem sufficient on which to base the conclusion that the western portion of Jonathan creek is flowing with reversed current in an old valley, (a valley whose maturity suggest that it is at least pre-Wisconsin, probably pre-Illinoian.) This valley continues westward to its union with Newark valley, at the northern margin of the lake and about a mile west of the Buckeye Lake terminal of the Ohio Electric railway. A gas well record in this field bordering the lake at this point shows that the rock floor has been excavated to 450 feet above sea level, 442 feet below the level of the lake. This is the deepest record found close to the lake and indicates the location of the outlet of the ancient tributary.

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16. Davis, H. J. Modification in the Jonathan creek drainage basin. Bull. Den. University 11: 165-173. Mar. 1899.

SUMMARY:

There seems to be sufficient evidence on which to base the conclusion that no large lake occupied the plain to the west and southwest of Newark after the recession of the late Wisconsin time.

The heavy bed of gravel between the late Wisconsin and Illinoian clays cannot have been deposited in a lake.

During the recession of the Wisconsin ice sheet a loop moraine was formed across the ancient valley of Jonathan creek just east of Thornville station.

The water imponded between the ice and moraine converted the lower portion of the valley into a lake.

The waters broke through the moraine forming a well defined overflow channel, not deep enough however to completely drain the valley.

This ancient basin is now occupied by Buckeye Lake.

The evidence obtained from gas well records corroborates the statements made by Read, Tight and Leverett of the existence and establishes the location and extent of Newark valley a pre-Illinoian valley from Newark, southwest to the Franklin county line.

This work was done under the direction of Dr. George D. Hubbard, now of Oberlin College, to whom I am much indebted for the assistance given in the field work and thru suggestions concerning and criticisms on this paper. I also take this opportunity to acknowledge my obligation to Miss Clara G. Mark for the excellent photograph and to Messrs. Bootin and Sawyer of the Canal Commission for information of Buckeye Lake.

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TABLE OF CONTENTS.

LIFE-HISTORIES OF SYRPHIDAE IV.

C. L. METCALF.

Allograpta obliqua (Say).
(Plate XXX, Figs. 61–70).

Egg.

Elongate oval in outline, narrowing slightly to the roundly-pointed anterior end and the truncate, posterior, micropylar end. The egg is slightly inflated dorsally, flattened against the surface to which it is attached ventrally. Length about 0.8 mm., diameter 0.3 mm. (Figs. 61 and 62.)

Color chalk-white with the usual microscopic sculpturing. (Fig. 63). When highly magnified, sometimes tinted with yellowish in the depressions between the sculptures. In this case the main bodies of the projections are broader than in *Syrphus americanus* (3 to 4 times as long as broad); somewhat oval in shape, the arms thicker and not so long as in *S. americanus*; usually about fifteen around each body. The space between the bodies is about two-thirds as wide as the body. There are about 28 of these projections the length of the egg, about 55 around it transversely at the middle.

Oviposition for the first spring generation began about the middle of May. A female taken on May 17 laid 35 eggs on May 22, 13 the following day, and by May 26, when she died, had deposited nearly 100 eggs. The first of these hatched the morning of the 25th, a few others the 26th, making the duration in the egg-stage (indoors) from 2.5 to 3.5 days.

In the field I have found eggs of this species on persimmon trees (*Diospyros virginiana L*), at the University Campus the last of May, and on curled dock (*Rumex crispus L.*) at Lakeville, Ohio, June 16–18. The eggs are deposited singly and laid flat on the surface of the leaf, twig, or flower.

I know no way of distinguishing these eggs from those of related Syrphidæ except by the size, shape and the microscopic characteristics of sculpturing described above; these may prove insufficient for specific separation when the eggs of more species are known.

Larva.

When just hatched (Fig. 65) the larvæ have a length of 1.2 mm., width 0.25 mm. They are irregular in outline, nearly cylindrical, broadest near the middle; feeble and inactive. Color whitish, with a yellowish or greenish tinge. The usual small, fleshy, conical elevations are present, twelve to each segment, but the segmental bristles were not discernible, apparently absent. The posterior breathing appendages are rather prominent, longer than in a young larva of *S. americanus*, and light in color like the rest of the body. Their tips are, at first, rather remote from each other though with subsequent growth and their greater elevation above the general body surface they become contiguous. The two longitudinal fat bodies are discernible as a white line on each side of the dorsal blood-vessel which is more prominent in the posterior half of the body. The skin is faintly wrinkled transversely.

From this condition there seems to be a gradual growth until the larva, when full-grown, has reached a length of about 8 mm., width 2 mm., heigth 1.25 mm. It may then be described as follows: Shape elongate oval, but much more pointed at the anterior end when extended. The outline is somewhat irregular due to folding and wrinkling of the skin. The posterior end is rounding, truncate except for the projections of the posterior breathing organ; (Fig. 66).

Color green, very similar to that of the cabbage leaf (on which they occur commonly) with two longitudinal white stripes. This color is due to colored visceral bodies which show through the transparent skin. Along the mid-dorsal line for two-thirds the length can be seen the narrow, dark, pulsating blood-vessel, its prominence varying with different specimens. It is irregularly limited at the sides by a narrow mass of greenish, fatty globules changing gradually to whitish. This whitish adipose matter forms the two prominent longitudinal white stripes, 0.2 or 0.3 mm. wide and extending to within a few millimeters of either end where they become much attenuated. The rest of the body, except the appendages is green, darker on the sides. The breathing tubes are light brown, black at the tips where the spiracles are located.

The skin is finely papillose when magnified. The character of the visceral matter often gives the larva a very granular appearance. The segments are marked by the usual twelve bristles in a transverse row. These are light in color, not elongate and not at all conspicuous; and are the only vestiture present.

The character of the mouth-parts is more or less perfectly represented by Figure 67. Owing to the lack of favorable material I was unable to verify this drawing and it may not be perfectly accurate. The outer pair of mouth-hooks is present.

The caudal branchial appendage is prominent, elongate, about 0.5 mm. in length by 0.125 mm. in breadth; of two cylinders fused mesad except at the extreme tip where they diverge slightly(Figs. 66, *c*; 68). The usual three elongate spiracles and circular plate are present on each half. The spiracular elevation is about three times as long as broad. There is a short, spur-like spiracular spine between each two spiracles, one between the most dorsal spiracle and the plate, and one mesad from the most ventral spiracle. These spines are continued down the sides of the tube as more or less evident ridges.

Larvæ of this species were found abundant on the leaves of flowers and fruit of the persimmon (*Diospyros virginiana L.*) on the University Campus June 1 and 2*. They were feeding on the nymphs of an undetermined species of *Aleyrodidæ* which caused a curling of the leaves.

An autumn generation occurs commonly on cabbage and related plants where they are predaceous on *Aphis brassicæ*. Larvæ were taken from this host-plant at the University Farm from September 20 to October 10.

Near Lakeville in Wayne Co., larvæ were taken from curled dock, June 16–18; and at Sandusky, Ohio, from the same plant June 23. These were among colonies of *Aphis rumicus*.

The larvæ are thus seen not to be closely restricted in their food habits, attacking at least two species of *Aphididæ* and one of *Aleyrodidæ*.

These larvæ live entirely on the surface of the plants where they are found and probably do not move farther than is necessary to secure their food. On the persimmon the larvæ were found on the flowers, but chiefly on the leaves, especially under the rolled up edges, where the Aleyrodid nymphs were commonest. On *Rumex* they were to be found mostly in the spikelets and on the under side of the leaves where the plant lice occur.

Whatever the host, the method of feeding is the same. The body-wall of the aphid is pierced by the mouth parts and the soft contents picked and sucked out while the head is pushed farther and farther inside the victim's skin.

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*I am indebted to my fellow-student, Mr. J. Lyonel King, for first calling my attention to these specimens.

The larvæ have no defensive structures so far as I am aware. Their color is probably of a great deal of protective value to them. On cabbage and on dock they very closely resemble the color of the leaves. On cabbage they are frequently in a position among the leaves inaccessible to predaceous enemies; on dock the under side of the leaf is not a conspicuous position; and on persimmon they are most commonly closely rolled about by the curling leaf.

Numerous larvæ of the autumn generation on cabbage are parasitized by the small Ichneumonid, *Bassus lætatorius* Fabr.†

Pupa.

Dimensions, average of eight: Length about 5.25 mm., maximum breadth 2.5 mm., maximum height 2.3 mm. This neglects the breathing tubes at the posterior end of the body which may project 0.5 mm. farther posteriorly or be directed more dorsally.

The puparium is broadest and deepest in front of the middle, the anterior end bulbous; strongly and evenly depressed and compressed to the posterior end, the posterior elevation very gradual. (See Figs. 69 and 70).

The color in this stage changes very decidedly during the development of the nymph within the translucent puparium. The color is not resident in the pupal envelope but due almost entirely to the inclosed matter. Consequently at first the colors are those of the larva—light pea-green with a brownish remnant of the dorsal blood vessel and, at the sides of this, the two whitish lines. The flattened posterior end of the puparium, including the breathing tubes, however, is light testaceous brown, the tips about the spiracles black. Midway on the length of the breathing appendages is a dark brown ring.

As the pupa developes within, the color changes, gradually losing all trace of the green and assuming more and more the colors of the adult. The first thing to be noticed is the reddish brown color of the eyes replacing the green in the anterior third of the pupa. Later the black and yellow abdominal markings become apparent.

The puparium is smooth, bare; the segmental spines inconspicuous. The breathing tubes as in the larva, prominent subcylindrical, the tips around the spiracles becoming black. The wrinkles of the skin often remain rather prominent.

Pupæ were found on persimmon June 1 to 5; on *Rumex* more or less continuously from the latter part of June, through July to August; and on cabbage from September 15 to October 15 In captivity a number of pupæ were formed between September 21 and October 1.

†See The Ohio Naturalist, Vol. XII, No. 5, pp. 483, 484, Mar., 1912.

The duration in the pupal stage varied in captivity from 3.5 to 5.5 days in the case of those taken from persimmon in the spring, while in Autumn in specimens from cabbage the duration in the pupal stage was in some cases as much as 10 days.

These pupæ are fastened by a viscid substance secreted by the anal glands of the larva which, in drying, glues them to various parts of the host-plant of the aphids among which they live. They attach to the flowers and in the curls of the leaves of persimmon, in leaf-axils, or flower spikes of *Rumex* and on cabbage among the outer leaves. In jars they attach to the cloth cover, the glass, or to leaves enclosed, apparently with no discretion.

The body shortens and thickens and the larval skin inflates and hardens in the usual manner. Within this puparium profound changes take place which culminate in the completely formed nymph, which has only to spread its wings and harden, after bursting out of the pupa case, to form the perfect fly.

Adult.

Description after Williston, Synop. N. A. Syrph., 96, 1886. (See Fig. 64.) "♂ ♀. Length, 6 to 7 mm. Face yellow, often with a bluish reflection, slightly brownish on the tubercle. Frontal triangle yellow; front in the female shining black on the vertex, continued as a broad stripe (broadest below) to the antennæ; on the sides the yellow of the face continues up along the eyes nearly to the ocelli. Antennæ reddish-brown, blackish on the upper part of the third joint. Thorax deep shining green, on the sides with a yellow stripe, reaching from the humeri to the suture, where it is sharply truncate; post-alar callosity also yellow. Scutellum wholly light yellow, faintly reddish on the disk; pile black. Abdomen black, or brown; first segment, except a slender transverse spot on each side behind, yellow; second segment with a slender yellow anterior fascia, and a broader one in the middle, about a third of the width of the segment, straight and but slightly widened at the sides; third segment with a broad arcuate band, not quite touching the posterior angles on the sides; fourth segment with two slender parallel stripes, leaving a slender black stripe between them, on each side a broader, oblique, oval spot, touching, or narrowly separated fron the anterior end of the yellow longitudinal stripe, and reaching to the posterior angles; fifth segment similar, but the side spots less oblique. Legs light yellow; last three joints of all the tarsi, the hind tibiæ, except the base and a middle ring, and a ring on outer part of hind femora, brownish. Wings hyaline, veins black."

Syphaerophoria cylindrica (Say).

(Plate XXX, Figs. 71-78).

Egg.

Length 0.9 mm., diameter 0.3 mm. Elongate oval, less pointed anteriorly than that of *Allograpta obliqua* but scarcely discernible from the latter, or from egg of *Syrphus americanus*, except possibly by microscopic examination.

Color chalk-white, sculpturing very similar to that of *Allograpta obliqua*. The projecting bodies however, appear, on the whole, to be shorter and broader than in that species, about two or three times as long as broad; distance between any two bodies about one-half the width of the body itself; number of arms around it 12 to 20, rather short, not much branched. Many of them ending at half the distance across the intervening space. Numbers of bodies around the egg at the middle about 50; number the length of the egg from pole to pole, very close to 30.

A female of this species taken on May 8, 1911, over grass, was confined and fed sweetened water. Four days later, May 12, 22 eggs were laid, and two the following day. None of these eggs hatched up to May 22, and were probably infertile, though it is possible that other conditions might have prevented normal development. Another female taken on May 13 laid only 2 eggs May 14; and a third, after being enclosed for some days, oviposited several dozen eggs on May 31. None of these hatched.

The eggs were deposited in the usual manner, the posterior ventral portion being glued to the surface. These little glistening white eggs seem to have no method of natural protection except the egg-shell which is leathery rather than fragile.

Larva.

Length 9 to 10 mm., height 1.25 mm., width 2.25 mm. Elongate oval, tapering at anterior end, somewhat truncate except for respiratory appendage at posterior end, depressed. Outline irregular, dorsal integument much wrinkled transversely, and with lateral, longitudinal carinæ. (Fig. 76).

Color pea-green with two, narrow, longitudinal, white stripes, laterad of and paralleling the rather conspicuous dark heart line. These white stripes and other coloring produced as in Allograpta; the stripes attenuated and confluent a little before the anterior end, not reaching the respiratory appendage posteriorly.

Respiratory appendage brownish black at the tip. The skin is papillose, bare except for the usual segmental bristles which are here short, light-colored and inconspicuous. There are a number

of poorly defined pro-leg-like projections of the body on the ventral side. The mouth-parts (Fig. 77) consist of three pairs of hooklets in addition to the pair of jaws. One pair of hooklets is short and heavy, triangular, lateral in position (Fig. 77, *d*), the other two pairs, situated close beside the jaws (*c*), are slender, elongate, slightly curved. The jaws (*b*) are of the usual type but U-shaped rather than V-shaped, the shoulders rather prominent, with a median, terminal, pointed projection.

The antennæ (Fig. 77, *a*) and anterior spiracles are rather well elevated. The latter on a fleshy base with a prominent constriction beyond the middle showing at the apex a small number of rounded teeth or lobes about three larger and three smaller ones. (Figs. 74, 75).

The shape, color and general appearance is very similar to the larva of *Allograpta obliqua*. So much so in fact that I was unable for a long time to distinguish the two and was being constantly baffled by the issuance of adult *Sphærophoria* from my stock of supposedly *Allograptid* larvæ and pupæ. There is an indefinable difference in the naked eye appearance as near as I can express it, due to the more finely and evenly granular appearance of the fat bodies visible through the dorsal wall in *Sphærophoria*. But I am not sure that this is constant.

The two species can, however, be very certainly and definitely separated on the basis of the posterior respiratory appendages. These are about the same length and other dimensions; the difference lies in the distal end. As described in *Allograpta obliqua* the two tubes are slightly divergent at the tip making them broader here than at mid-length, and bear between each two spiracles a short, but readily visible, spur-like elevation continued as a slight ridge down the side of the tube. Now in *Sphærophoria cylindrica* the end of the tube is very nicely and evenly rounded off; the spiracles very slightly elevated; the two tubes slightly emarginate but not at all divergent, and all trace of inter-spiracular spines or projections lacking. With the aid of a good hand lens one can always separate these two species at a glance when the characters have once been fixed in mind. (See Figs. 72 and 73 and compare Figs. 66 and 68).

On June 4th larvæ of this species were taken from among *Aphis brassicæ* in a greenhouse on the University Campus. At Sandusky, larvæ were found commonly on curled dock (*Rumex crispus*) June 20th and later. At Lakeville, larvæ were taken from thistle (*Carduus sp.*) among *Aphis sp.* August 27, 1911. In Autumn they are rather common on cabbage, in gardens during September. *Aphis brassicæ* Linn. seems to be their favorite prey, though they are not restricted to this species, and may be found to be rather ubiquitious.

As in *Allograpta obliqua* these larvæ are colored like the leaves on which they commonly feed and this is probably of some protection to them. They are also parasitized by *Bassus lætatorius*.

Pupa.

Dimensions, average of six: Length, neglecting the posterior respiratory appendage, 5.3 mm., height 2.05 mm., width 2.1 mm. In general shape, color, and appearance so similar to *Allograpta obliqua* as scarcely to permit of separate description. The puparium is generally less strongly elevated posteriorly, (See Fig. 78*cf*, Fig. 70.) The characters of the posterior respiratory appendages however remain as in the larva and will always serve to distinguish the species from *A. obliqua*.

Pupation was observed to occur in an open greenhouse Columbus, Ohio, June 5, 1911. On *Rumex crispus*, Sandusky, the 23rd of June and later, and from the middle of September to the middle of October on cabbage. The pupæ were glued to the more or less exposed surfaces of the leaves among which the larvæ had fed. The duration in the pupal stage (indoors) was 5 to 7 days.

Adult.

The following description modified after Williston, Synop. N. A. Syrph. applies to the adults reared from the larvæ and pupæ described above. (See Fig. 71).

♂. Length, 6 to 8 mm. Face and front light yellow, shining; tubercle and anterior oral margin somewhat fuscous. Antennæ reddish yellow, sometimes brownish above on third joint. Dorsum of thorax dark greenish olivaceous, somewhat shining, with an abbreviated lateral stripe reaching only to the suture, or very indistinct back of the suture; two more or less prominent grayish pollinose stripes on the anterior part near the middle line; pleuræ deep shining, somewhat bluish black, with light yellow spots as follows: a large one under the base of the wing, irregular in shape, imperfectly divided, covering the pteropleura and parts of the mesopleura and metapleura; and three smaller ones, one above the base of each coxa; which, except the front one, may be continuous with the larger spot; scutellum sulphur yellow. Abdomen slender; first segment black except on the sides; second segment with a broad yellow cross-band in the middle, and a brown or black band half its width in front and behind, not reaching the lateral margin. Remaining abdominal segments more or less variable; third segment narrowly brown or blackish in front and behind, elsewhere reddish yellow; fourth segment yellow and obscurely brownish; fifth segment and hypopygium wholly reddish yellow, the latter globose and with a tuft of pile below in front. Legs yellow including the coxæ, the tarsi more or less infuscated. Wings nearly hyaline, not exceeding the abdomen.

♀. Front shining black, yellow on the sides below; yellow lateral stripes of thorax extending only to the suture. Abdomen moderately broad, shining black with the extreme lateral margins continuously yellow and a moderately arcuate, entire, yellow band, reaching the yellow on the sides, on each of the segments from two to four inclusive. These bands cover about one-third the length of the segment. Fifth segment with a similar but slenderer yellow band interrupted in the middle. Sixth segment yellow with some black on the disk. In other respects as in the male.

EXPLANATION OF PLATE XXX.

Figures 61–70 *Allograpta obliqua* (Say).

Fig. 61. Egg from the side x 20.

Fig. 62. Dorsal view of egg x 20.

Fig. 63. A small part of the surface of egg-shell showing sculpturing, highly magnified.

Fig. 64. Adult ♀ about 7 times natural size.

Fig. 65. Larva, 12–24 hours after hatching x 50; *a*, antenna; *b*, internal oesophageal framework; *c*, posterior respiratory organs.

Fig. 66. Mature larva x 9; *a*, antenna; *b*, position of anterior spiracles; *c*, posterior respiratory appendages.

Fig. 67. Antero-ventral view of the head of the larva, much enlarged; *a*, antenna; *b*, upper jaw;*c*, outer pair of mouth-hooks; *d*, the two pairs of lateral mouth hooklets; *e*, chitinous oesophageal framework (internal); *f*, lower jaw.

Fig. 68. End view of posterior respiratory organ x 200; *a*, one of the six elongate spiracles, *b*, the dorsal, circular plate; *c*, *c*, the interspiracular spines.

Fig. 69. Dorsal view of puparium x 5; *a*, posterior respiratory appendage.

Fig. 70. Outline of puparium from the side x 3.5; *a*, posterior respiratory appendage.

Figures 71–78 *Sphaerophoria cylindrica* (Say).

Fig. 71. Drawing of the adult male from the side x 7.

Fig. 72. Terminal part of mature larva x 60, showing respiratory apparatus; *a*, slit-like spiracles; *b*, dorsal circular plate.

Fig. 73. End-view of posterior respiratory appendage x 120; lettering as in Fig. 72.

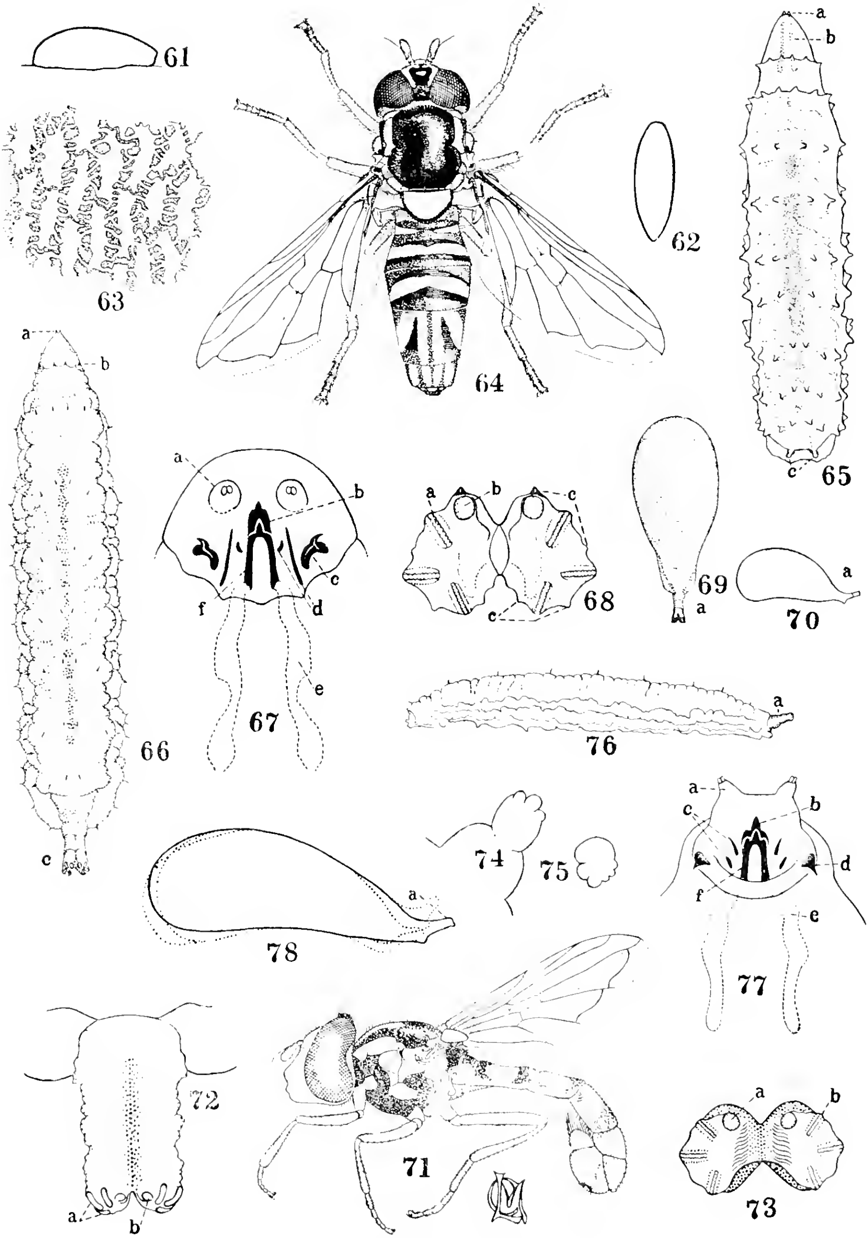
Fig. 74. Side view of anterior respiratory appendage, highly magnified.

Fig. 75. The same from the end, showing teeth-like lobes.

Fig. 76. The larva from the side x 5; *a*, posterior respiratory appendage.

Fig. 77. Antero-ventral view of head segments, much enlarged; *a*, the antenna; *b*, the upper jaw; *c*, the two pairs of mouth-hooks close beside the jaws; *d*, the outer pair of mouth-hooks; *e*, chitinous oesophageal framework (internal); *f*, lower jaw.

Fig. 78. Outline of puparium from the side x 7.5; the dotted lines indicate several variations in the shape of puparia.



METCALF on "Life-Histories of Syrphidae IV."

ALPHABETICAL LIST OF LICHENS COLLECTED IN SEVERAL COUNTIES OF NORTHERN OHIO.

Edo Claassen.

Very little attention appears to have been given to the collection of Lichens in Ohio since E. E. Bogue published his list of Ohio Lichens. The cause of this may be to some extent in a lack of the necessary assistance in their determination. Since the appearance of Tuckerman's work, the most important is, no doubt, Fink's "The Lichens of Minnesota." As nearly all Lichens of Northern Ohio are apparently treated in this work it is of great value to all students desiring to determine the Lichens of the northern counties. Together with Tuckerman's "Synopsis," Sydow's "Die Flechten Deutschlands," Boistel's "Les Lichens de la France," Hepp's "Abbildungen der Flechtensporen," and several other works, it was of great use to the writer in his determinations.

The names of the counties, where each lichen was collected, are abbreviated in the list: C stands for Cuyahoga, E for Erie, G for Geauga, L for Lake, M for Medina, O for Ottawa, P for Portage, S for Summit, and St for Stark. The numbers following the abbreviations indicate the number of places where each species was found. Most of the Lichens were noted to occur in Cuyahoga county, where the writer's residence is located. As much as possible of the mode of occurrence was noted, namely, on bark, on rock, etc. Notwithstanding careful investigation in the course of about 10 years, several Lichens were found in but one or two localities; they are considered to be rare or hard to detect on account of their small size. The following ones may be named here:

Acarospora fuscata (Schrad.) Th.Fr.
Arthopyrenia conoidea (Fr.) Fink.
Bacidia umbrina (Ach.) Branth. & Rostk.
Bilimbia naegelii (Hepp) Zwackh.
Bilimbia sphaeroides (Dicks.) Koerb
Cetraria islandica (L.) Ach.
(This lichen has disappeared from its locality, without having been found somewhere else.)
Cladonia coccifera (L.) Willd.
Conotrema urceolatum (Ach.) Tuck.
Lecanora muralis (Schreb.) Tuck.
Lecidea uliginosa (Schrad.) Ach.
Parmelia conspersa (Ehrh.) Ach.
Rhizocarpon alboatrum saxicolum (Fr.) Fink.
Sphinctrina tubaeformis Mass.
Stereocaulon coralloides Fr.
Teloschistes chrysophthalmus (L.) Fr.

More species undoubtedly occur in these counties and by diligent work all may be found sooner or later. Specimens of those listed above and from all the localities are deposited in the writer's

herbarium. It is to be hoped, that this list may be helpful to students of lichenology in this state and induce other botanical workers to commence the study of this very interesting branch of natural science.

List of Lichens:

Acarospora puscata (Schrad.) Th. Fr. On sandstone: C 2 G 1.
Alectoria jubata chalybeiformis (L.) Ach. On fencerails: C 4 G 2 P 4 S 1; on rock: L 1.
Arthonia punctiformis Ach. On bark (Ash, hickory, ptelea): C 2 E 1.
Arthonia radiata (Pers.) Ach. On bark (Alder, ash, basswood, hickory, maple, sycamore): C 16 L 3 O 1.
A. radiata swartziana (Ach.) Willey. On bark: C 1 E 1.
Arthopyrenia conoidea (Fr.) Fink. On limestone: O 1.
Arthopyrenia gemmata (Ach.) Mass. On bark (Dogwood, sycamore): C 4 S 1.
Arthopyrenia punctiformis (Pers.) Mass. On bark (Ash, maple): C 8.
Arthothelium spectabile Mass. On bark (Ash, birch, horse-chestnut, maple): C 43 L 1 O 1 S 3.
Bacidia fuscorubella (Hoffm.) Arn. On bark (Dogwood, elm, maple): C 8 L 1 S 1.
B. fuscorubella suffusa (Fr.) Fink. On limestone: O 1.
Bacidia rubella (Hoffm.) Mass. On bark (Ash, elm, maple, willow): C 12.
Bacidia Schweinitzii (Tuck.) Fink. On bark (Ash, birch, maple): C 16 G 2 L 1 M 1.
Bacidia umbrina (Ach.) Branth. & Rrostk. On argillaceous slate and sandstone: C 4.
Baeomyces byssoides (L.) Ach. On clayey ground: C 2.
Bilimbia hypnophila (Ach.) Fr. On bark (Hickory, sycamore, willow) and moss covered rock: C 18 G 2 O 2 P 2 S 2.
Bilimbia naegelii (Hepp) Zwackh. On bark (Basswood): C 1.
Bilimbia sphaeroides (Dicks.) Koerb. On old bark (Witch-hazel): C 1.
Buellia parasema (Ach.) Koerb. On bark (Alder, ash, beech, chestnut, hickory, maple, oak, w. cherry): C 11 E 1 G 1 L 1 P 2 S 3.
Calicium parietinum Ach. On bark (Sycamore): C 3.
Cetraria ciliaris Ach. On fence rails and dead Tamarack branches: C 2 G 2 L 1 P 3 S 2.
Cetraria islandica (L.) Ach. On earth: C 1.
Cetraria lacunosa Ach. On fence rails and old wood: C 2 P 1 S 4.
Cladonia bacillaris (Del.) Nyl. On rotten wood: C 1.
Cladonia caespiticia (Pers.) Floerke. On old wood: C 4 L 1 M 1.
Cladonia coccifera (L.) Willd. Over moss on earth: C 1.

Cladonia cristatella Tuck. On earth, old wood and over moss on rock: C 30 E 1 L 1 S 2.
Cladonia fimbriata (L.) Fr. In its varieties: cornutoradiata Coem., simplex (Weiss) Wainio, subulata (L) Wainio. On decaying wood: C 3.
Cladonia furcata (Huds.) Schrad. On earth, old bark and old wood: C 20 L 1 S 1.
Cladonia gracilis (L.) Willd. On old bark and wood: C 5 E 1 S 1 St 1
Cladonia mitrula Tuck. On earth, old bark and wood: C 19 G 1 S 2
Cladonia pyxidata (L.) Hoffm. On earth, old bark, old wood and over moss on the ground: C 32 E 1 S 3.
Cladonia rangiferina (L.) Hoffm. On earth, rock and old wood: C 7 E 1 L 3.
Cladonia silvatica (L.) Hoffm. On earth: C 3 E 1.
Cladonia squamosa (Scop.) Hoffm. On rock, old bark and wood: C 9 L 2 S 1.
Cladonia subcariosa (Nyl.) Wainio. On earth: C 4.
Cladonia verticillata Hoffm. On earth, old bark and wood: C 32 L 2 S 1.
Coniocybe pallida (Pers.) Fr. On moss and old bark: C 2.
Conotrema urceolatum (Ach.) Tuck. On bark (Chestnut): L 1.
Dermatocarpon miniatum (L.) Fr. On limestone: O 3; on sandstone: S 1.
Evernia prunastri (L.)Ach. On fence rails: C 1 G 1.
Graphis scripta L. On bark (Alder, ash, beech, chestnut, elm, hickory, ironwood, sycamore, whitewood): C 36 G 3 L 2 O 1.
G. scripta recta Nyl. On bark (Birch): C 3.
Gyalecta cupularis (Hdw.) Schaer. On limestone: O 3.
Lecanora hageni Ach. On bark (Dogwood): S 1.
Lecanora muralis (Schreb.) Schaer. On sandstone: C 1.
Lecanora pallida (Schreb.) Schaer. On bark (Ash, hickory, maple): C 18 E 2 G 4 L 2 P 1 S 2.
Lecanora pallescans (L.) Schaer. On old bark and bark (Beech, maple, oak): C 3 G 1.
Lecanora subfusca (L.)Ach. On bark (Alder, ash, beech, birch, hickory, ironwood, maple, w. cherry, willow): on fence rail; on rock (Amphibolite), limestone and sandstone: C 38 E 4 G 2 L 3 O 5 P 2 S 6.
L. subfusca allophana Ach. On bark (Beech, birch, hickory, whitewood): C 3 E 1.
Lecanora varia (Hoffm.) Ach. On bark (Alder, beech, cherry, hemlock, hickory, sycamore, tamarack, wild cherry, willow) and dead wood: C 4 E 1 G 6 O 1 P 5 S 2.
Lecidea albocoerulescens (Wulf.) Schaer. On sandstone: C 10 G 2 L 1 S 1.
Lecidea coarctata (G. E. Smith) Nyl. On argillaceous slate and sandstone: C 4.

Lecidea contigua Fr. On sandstone: C 2.
Lecidea cyrtidia Tuck. On sandstone: C 6 S 1.
Lecidea enteroleuca Ach. On bark (Alder, ash, hickory, willow) and on rock: C 3 G 1 O 2 S 1.
Lecidea platycarpa Ach. On argillaceous slate and sandstone: C 28 S 1.
Lecidea speirea Ach. On sandstone: C 4 S 1.
Lecidea uliginosa (Schrad.) Ach. On earth: C 2.
Lecidea vernalis (L.) Ach. On decayed wood: C 1.
Lecidea viridescens (Schrad.) Ach. On decayed roots and over moss: L 1 S 1.
Leptogium lacerum (Retz.) S. F. Gray. On old bark and over moss on rock: C 2 O 2.
Leptogium pulchellum (Ach.) Nyl. On old bark and moss: C 4 M 1
Leptogium tremelloides (L.) S. F. Gray. On moss over old bark and limestone and on boulder: C 6 O 1 S 1.
Mycoporum sparsellum Nyl. On bark (Ironwood): S 1.
Nephroma laevigatum Ach. On old bark: C 2.
Omphalaria pulvinata (Schaer.) Nyl. On limestone: O 1.
Opegrapha varia Pers. incl. var. notha, (Ach.) Nyl and pulicaris, (Ach.) Nyl. On bark (Basswood, chestnut, elm, maple, sycamore, willow): C 14 G 1 L 1 O 2.
Opegrapha viridis Ach. On bark (Elm, oak): C 3 O 1 S 1.
Opegrapha vulgata Ach. On bark (Ash, maple, sycamore): C 4.
Pannaria nigra (Huds.) Nyl. On limestone: C 1 O 3.
Parmelia borreri rudecta (Ach.) Tuck. On bark (Hickory, maple, oak, red cedar) and old bark: C 6 E 9 O 3 P 1 St 1.
Parmelia caperata (L.) Ach. On bark (Beech, hickory, oak, sycamore, willow); over moss; on fence rails and on rocks: C 16 G 1 L 1 M 2 O 1 P 4 St 1.
Parmelia conspersa (Ehrh.) Ach. On sandstone: C 1.
Parmelia olivacea (L.) Ach. On bark (Birch, oak, willow): C 1 E 3.
Parmelia perforata (L.) Ach. On bark (Maple, oak): C 1 M 1.
Parmelia perlata (L.) Ach. On bark (Maple); on rock: C 4 E 1 G 1 M 1.
P. perlata ciliata (Lam. & DC.) Schaer. On bark (Hickory, maple): C 6 G 1 O 2.
Parmelia physodes (L.) Ach. On bark (Ash, willow); on fence rails and dead tamarack branches: C 2 G 1 P 3.
Parmelia saxatilis (L.) Ach. On bark (Hickory, maple, willow); on old bark, on rock and moss over rock: C 12 G 1 L 1 M 2 O 1 P 2.
Parmelia tiliacea (Hoffm.) Ach. On bark (Alder, ash, hickory, maple, willow): C 9 G 3 L 1 M 3 P 4 S 2.
Peltigera aphthosa (L.) Willd. On rock and over moss on rock: C 5 L 1 S 1.

Peltigera canina (L.) Hoffm. On earth, rock and bark: C 12 G 1 P 1.
P. canina spuria (Ach.) Tuck. With moss on old wood and bark and on earth: C 3 E 1.
Peltigera horizontalis (L.) Hoffm. Over moss and decayed leaves; on earth and on rock: C 6 L 1.
Peltigera polydactyla (Neck.) Hoffm. Over moss on earth and rock: C 3.
Pertusaria communis Lam. & DC. On bark (Ash, beech, birch, hickory, maple) and on rock: C 26 G 2 L 4 M 1 O 1 S 2.
Pertusaria leioplaca (Ach.) Schaer. On bark (Maple): C 3 E 1 L 1.
Pertusaria multipuncta (Turn.) Nyl. On bark (Hickory): C 2 E 1 O 2.
Pertusaria pustulata (Ach.) Nyl. On bark (Alder, apple, ash, birch, chestnut, hickory, ironwood, oak, thorn, wild cherry): C 16 G 2 L 7 O 2 S 3.
Pertusaria velata (Turn.) Nyl. On bark (Ash, hickory, maple): C 12 G 3 S 3.
Physcia adglutinata (Floerke) Nyl. On bark (Basswood, hickory, maple, oak, willow): C 8 E 1 O 2.
Physcia aguila detonsa (Fr.) Tuck. On bark (Beech,birch,): on old bark and moss over old bark: C 18 E 2 L 1 M 3 S 2.
Physcia hypoleuca (Ach.) Tuck. On bark (Maple, willow) and on old bark: C 11 E 2 M 3.
Physcia obscura (Schaer.) Nyl. On bark (Ash, basswood, elm, hickory, maple, poplar, willow); on rock and over moss on bark and rock: C 12 E 2 O 2 St 1.
P. obscura endochrysea (Hampe) Nyl. On bark (Willow): C 1.
Physcia speciosa (Wulf.) Nyl. On bark (Elm, poplar); on fence rail; on boulder; on moss over old bark and rock: C 8 E 2 G 1 M 2 O 2 St 1.
Physcia stellaris (L.) Nyl. On bark (Apple, ash, elm, maple, oak, poplar, red cedar, willow) and on rock: C 40 E 15 G 4 M 1 O 6 P 3 S 2 St 1.
Physcia tribacia (Ach.) Nyl. On bark (Apple, crab-apple, hickory, maple, sycamore, thorn, wild cherry, willow): C 9 E 4 G 1 O 2.
Placodium aurantiacum (Lightf.) Hepp. On limestone, on sandstone and on dead bark: C 6 E 1 O 2.
Placodium cerinum (Hoffm.) Hepp. On bark (Ash, hickory, maple, oak, willow): C 5 E 1 M 1 O 2.
Placodium vitellinum (Hoffm.) Hepp. On sandstone: C 2 G 1.
Pyrenula cinerella (Flot.) Fink. On bark (Birch, hemlock, oak, wild cherry): C 7 L 3 O 2 S 1.
Pyrenula leucoplaca (Wallr.) Koerb. incl. var. pluriloculata, Fink. On bark (Beech, birch, maple, oak, wild cherry): C 6 L 2.

Pyrenula nitida (Weig.) Ach. On bark (Ash, beech, birch, ironwood, oak, poplar): C 23 S 1.
Ramalina calicaris (L.) Fr. On bark (Alder, ash, hickory, oak, willow) and on dead wood: C 4 G 3 M 3 O 1 P 3
R. calicaris farinacea (L.) Fr. On sandstone: C 1 L 1.
R. calicaris fraxinea (L.) Fr. On bark (Oak): C 2 E 1.
Rhizocarpon alboatrum saxicolum (Fr.) Fink. On limestone: O 1.
Rhizocarpon petraeum (Wulf.) Koerb. On sandstone: C 5.
Rinodina sexigua Ach. On bark (Apple): C 1.
Rinodina sophodes (Ach.) Koerb. On bark (Ash, hickory, ptelea); on limestone and sandstone: C 3 E 3 G 1.
Sphinctrina tubaeformis Mass. On thallus of Pertusaria pustulata (Ach.) Nyl. occurring on hickory bark: O 1.
Stereocaulon coralloides Fr. On sandstone: C 2.
Sticta amplissima (Scop.) Mass. On bark (Beech, maple, oak, sycamore) and over moss on old bark and rock: C 17 G 1 P 1.
Sticta pulmonaria (L.) Schaer. Over moss on bark (Ash) and on old bark (Sycamore): C 2 M 1 O 1.
Synechoblastus nigrescens (Huds.) Stitzenb. On bark (Maple) and on old bark: C 3.
Teloschistes chrysophthalmus (L.) Fr. On bark (Oak) and dead branches (Red cedar): E 1.
Teloschistes concolor (Dicks.) Tuck. On bark (Apple, hickory, maple, oak, poplar, red cedar, willow): C 7 E 2 O 3 P 3.
Teloschistes lychneus (Ach.) Fr. [incl. var. polycarpus, (Hoffm.), Tuck.] On bark (Apple, oak, poplar, willow): C 4 E 6 M 1.
Trypethelium virens Tuck. On bark (Beech, ironwood): C 6 L 1 S 1.
Usnea barbata Fr. On bark (Alder): P 1.
U. barbata hirta (L.) Fr. On bark, on dead branches (Red cedar) and on rock: C 3 G 1 L 2 M 1 P 3 S 1.
Verrucaria fuscella (Turn.) Ach. On sandstone: C 1.
Verrucaria muralis Pers. On limestone and sandstone: C 3 O 4.
Verrucaria nigrescens Pers. On sandstone: C 1.
V. nigrescens viridula (Schrad.) Nyl. On argillaceous rock: C 1.

MEETINGS OF THE BIOLOGICAL CLUB.

ORTON HALL, February 12, 1912.

The Biological Club met at 7:30 p. m. with the president, W. M. Barrows, presiding. The program of the evening consisted of an interesting and instructive lecture, "Among the White Mountains" by J. C. Hambleton.

For several years Mr. Hambleton has had charge of a boys' camp located in southwestern New Hampshire near the Connecticut River. During the course of his lecture a goodly number of fine lantern slides were shown. The lecture was particularly valuable in showing the many interesting physiographic, geological, floral and æsthetic features of the region around the camp; and particularly those incident to a trip in the White Mountains and the climbing of Mt. Washington.

Professors Schaffner and Osborn gave brief reports of a few of the more interesting papers presented at the Washington meeting of the American Association for the Advancement of Science.

Dr. R. J. Seymour and Mr. Charles F. Stiles were elected to membership.

ORTON HALL, March 4, 1912.

The Club was called to order at 7:45 p. m. by the president. The first subject of the evening was by Prof. C. J. West on "The Law of Probability." Prof. West spoke of the necessity of mathematical knowledge on the part of the biologist who is doing statistical work. While this work does not require very difficult mathematics it does require great care to avoid errors.

The development of statistical work was shown from its beginning in solving the problems of the gambler to its present status. Since a finite number of measurements is never absolutely correct this science is now used in all the more delicate experimental sciences as a corrector of our erroneous senses. By this means also a set of constants may be made to stand for a great series of unintelligible data. Prof. West explained the development of a number of the formulæ as those for the law of mortality, the law of probability and the probable error.

J. L. King read an interesting paper on "The Life of Galton." Galton was one of the earliest scientists to use the statistical methods.

R. D. Whitmarsh was elected to membership.

ORTON HALL, April 1, 1912.

After reading and approval of the minutes, the Club listened to an informal talk by Dr. A. M. Bliele on a recent trip to Italy. Dr. Bleile told in a delightful manner about the people of the different places visited, their characteristics and manners of life; of visits to a half-extinct volcano and to Pompeii; of the monuments and ruins, the art palaces and cathedrals at Rome, Florence and Venice; and of the museum, aquaria, bacteriological and zoological institutes and other educational institutions at Naples, Pompeii and Vienna.

Mr. Forest Brown reviewed a series of papers by Raunkiaer on "The Statistics of Life-forms as a Basis for Biological Plant Geography." The author has made numerical studies of the position of buds in plants surviving the unfavorable season. He is able thus to classify plants into some thirty types the distribution of which he has traced in North America, Europe, and various other portions of the globe. Five of these are as follows: (1) Phanerophytes (trees) with surviving buds supported above the soil; (2) Geophytes with surviving buds at the earth's surface; (3) Hemicryptophytes with surviving buds just beneath the surface; (4) Cryptophytes with surviving buds deep in the earth; (5) Therophytes which survive only as seed.

With such data Raunkiaer has been successful in plotting biochores, or biological boundary lines, and in defining a number of life-zones which he farther shows to be determined by climate.

C. L. METCALF, *Secretary.*

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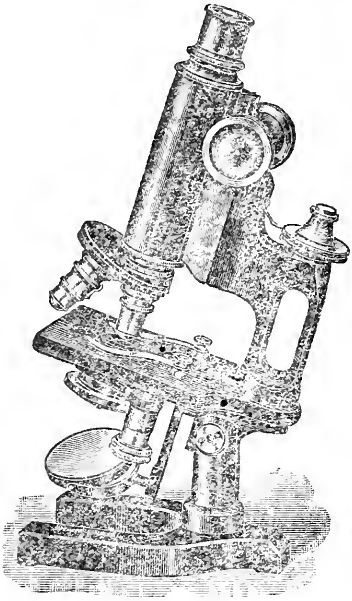

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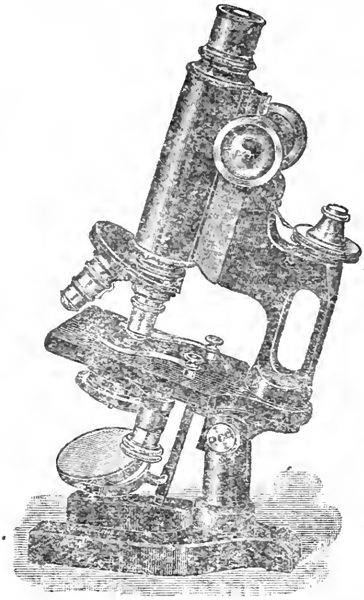

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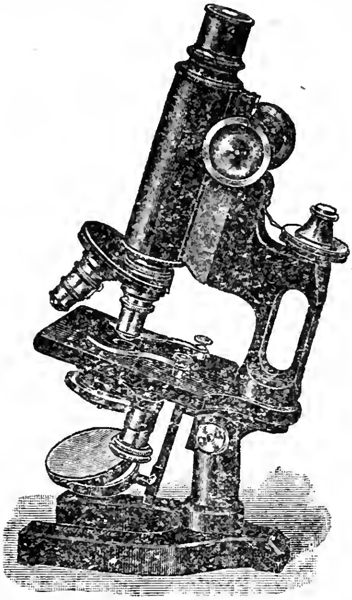

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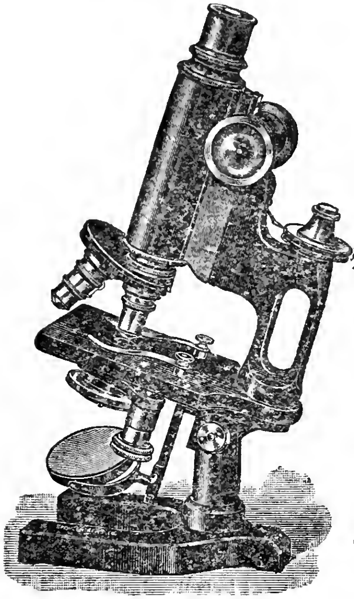

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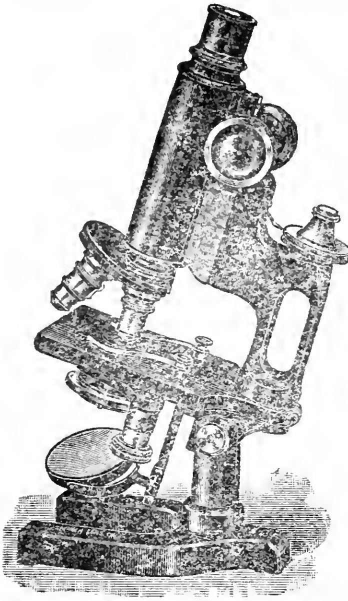

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APRIL,

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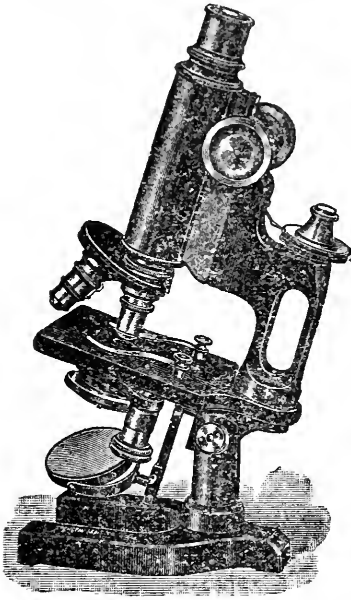

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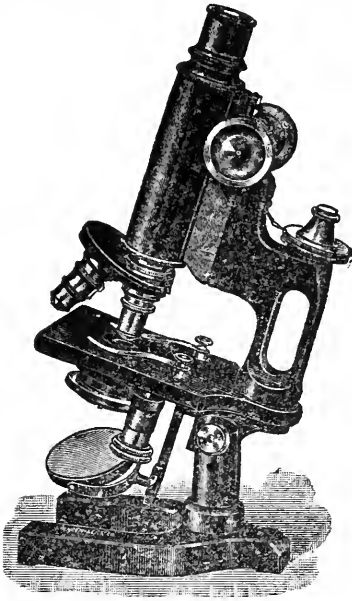

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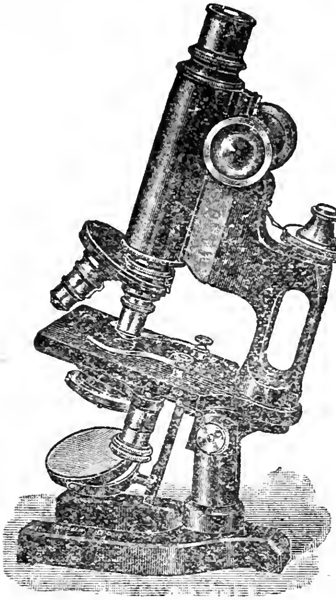

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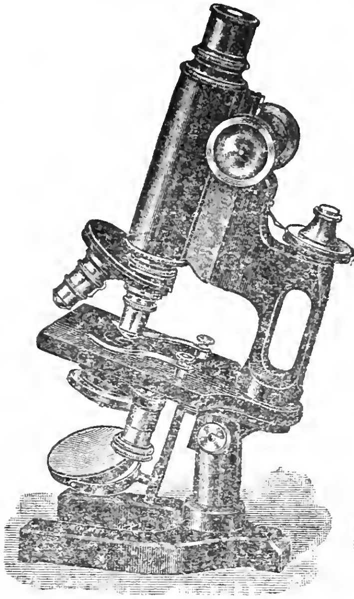

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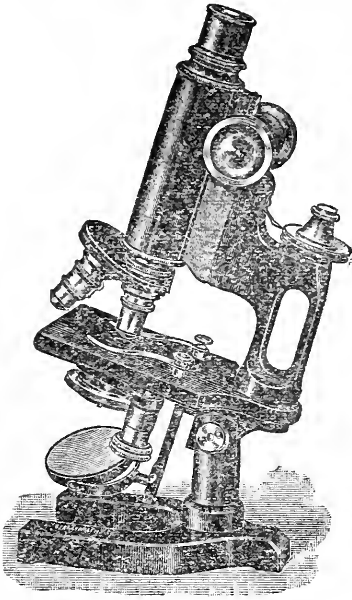

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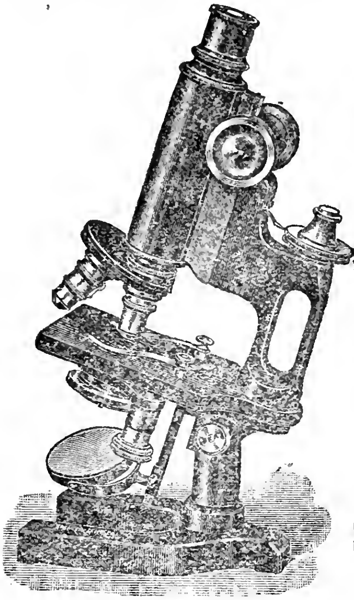

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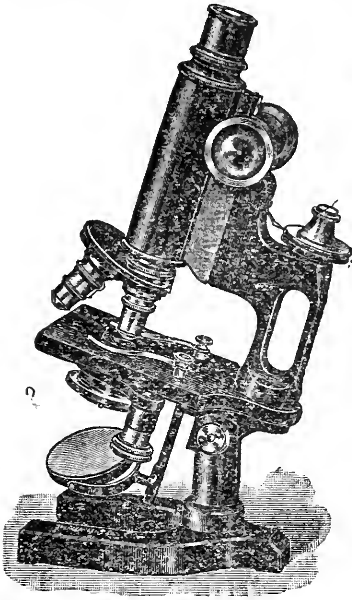

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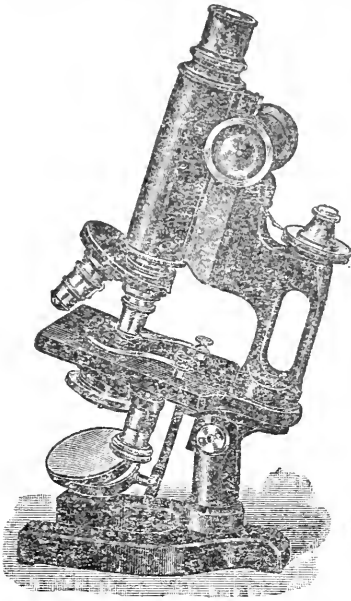

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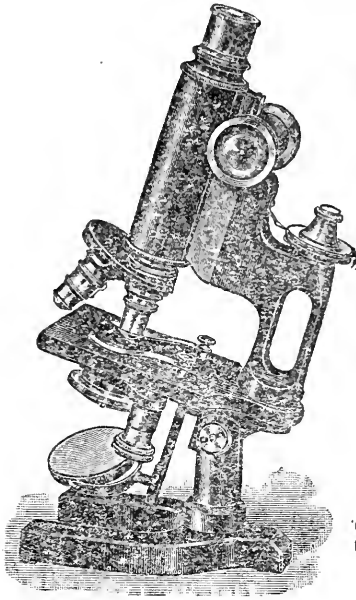

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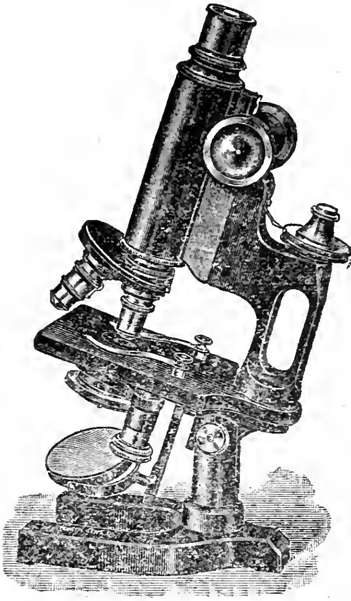

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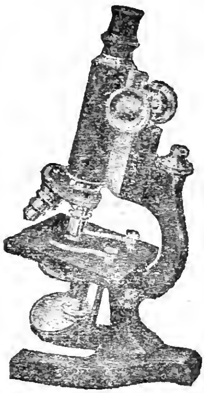

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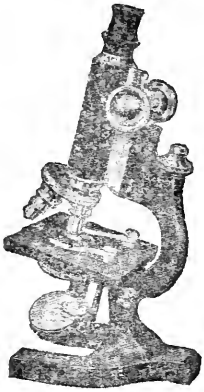

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JANUARY,

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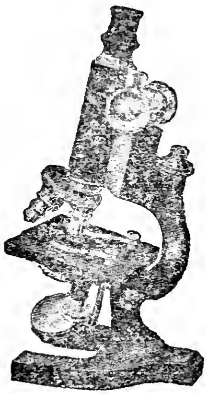

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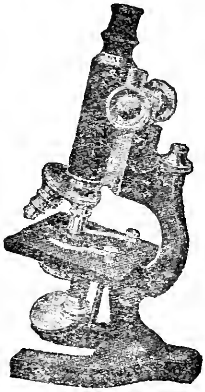

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OFFICIAL ORGAN *of* THE BIOLOGICAL CLUB *of the* OHIO STATE UNIVERSITY, *and of* THE OHIO ACADEMY *of* SCIENCE.

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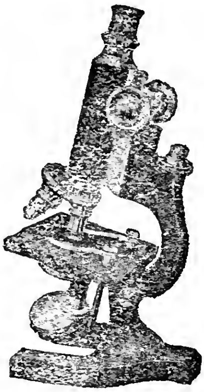

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